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Vol. 15 MARCH, 1944 No. 3

SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

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Vol. 15, No. 3, March, 1944. Surgery is published monthly by The C. V. Mosby Company, 3523 Pine Blvd., St. Louis (3), Mo. Subscription price: United States, its possessions, Pan-American Countries, $10.00 a year; Canada, $11.50 (Canadian Currency); Foreign, $11.00. Entered as Second-Class Matter January 20, 1937, at the Post Office at St. Louis, Missouri, under the Act of March 3, 1879. Printed in U. S. A.

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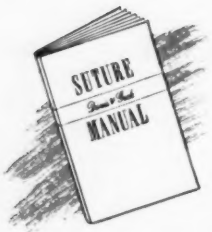

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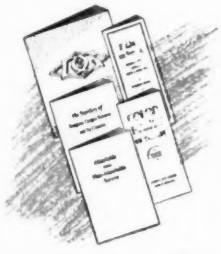

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D & G has prepared a number of booklets which, although they are devoted to special products offered by the company, may be used as reference on certain technical phases of suture use. Sample titles: Fine-Gauge Catgut in Gastrointestinal Surgery; Special Atraumatic Sutures for Use in Eye Surgery; Ribbon Gut (Its Description and Use).

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TO THE SURGICAL PROFESSION

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Catgut chromicized *after* the suture is fabricated, provides:

1. maximal strength during early stages of healing

2. uniform absorption periods for all sizes

There are two basically different methods employed for the chrome tanning of catgut. In one, the strips of gut are pre-tanned before being manufactured into the finished strand. In the other, the strand is fabricated first and then subjected to the chrome tanning process.

In the pre-tanning method, the various sizes of sutures are made up of similarly tanned material. Therefore, their absorption VARIES according to the diameter of the strand. This means that large size sutures may remain too long in the tissues and small sizes absorb too quickly.

The D & G post-tanning process perfected through more than a third of a century of research and extensive clinical evidence, eliminates this defect in behavior by providing individual treatment of each size. Under this method the finest size is the most thoroughly tanned, the next larger slightly less, and so on—each to the exact degree required to insure proper absorption. Since the process is applied to completed strands of known diameter, it can be controlled with great accuracy to produce sutures of predictable behavior regardless of size.

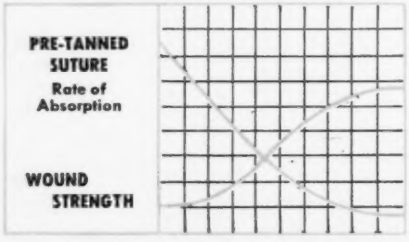
Another shortcoming of sutures produced from pre-tanned gut derives from the fact that the outer surface is no more thoroughly tanned than the center. Since absorption takes place in proportion to the area exposed to tissue fluids, this means that such sutures lose strength most rapidly in the early stages of healing when the wound is weakest.

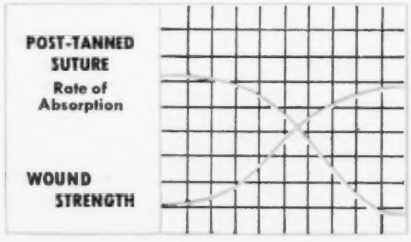
This is exactly opposite to the proper function of a suture which is to RETAIN its maximal strength during the early stages of healing, and then to disappear rapidly as the wound gains strength.

Under the D & G post-tanning method, the outer surface of the strand is tanned to a greater degree than the center. This protects the outer surface from absorption and preserves the original size and strength of the suture during early healing when maximal suture strength is needed.

PRE-TANNED **POST-TANNED**

By the time the outside of the post-tanned suture is absorbed, healing will be well under way and prompt absorption of the suture desirable.





The curves demonstrate how the pre-tanned suture loses strength rapidly in early stages of wound-healing, whereas the post-tanned suture retains maximal strength during this period when strength is most needed.

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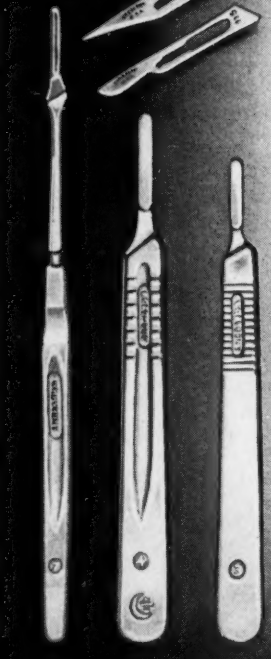

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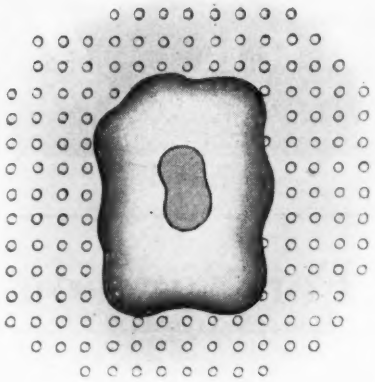

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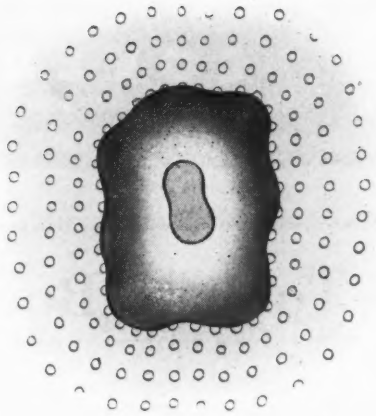

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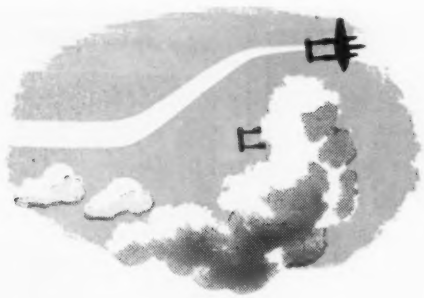

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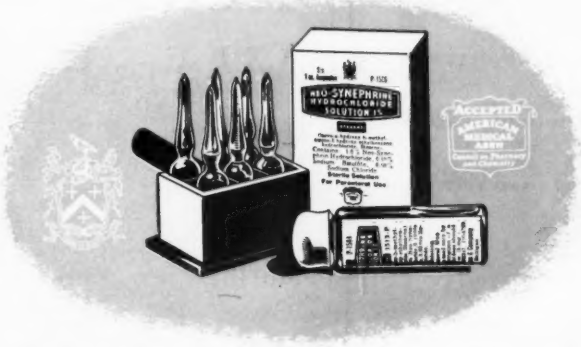

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t so far I have learned of no other suggestion which provides the necessity valve which such an arrangement would give. It would be tragic if a lot business concerns were wrecked and rkers thrown into idleness because of ability to cut through the red tape in getting their claims settled.

PONSIBILITIES OF CONTRACTORS

making these statements with reaction by the Federal authorities, I , also, that business concerns which contracts have a responsibility on t to facilitate speedy settlement of ed war contracts. They have the reity for preparing their claims acand speedily and presenting them r form. Some progress has been ward getting a recognition of the t industry must play in this respect, ently more and more experience of is now being gained. The conervices of the Government, I know, ry helpful attitude toward this sitnd the local office of W. P. B. has d a regional advisory service for war ced with problems resulting from termination. That is a very helpful ment.

ation to make possible the prompt nt of terminated war contracts is ow. It will be unsafe to wait until a deluge of contract terminations to ough legislation on short notice. em is too complicated to be dealt tively in that way.

ERIALS FOR CIVILIAN PRODUCTION

dition to making provision for the nt of terminated war contracts, there he task of facilitating the flow of for civilian production as soon as terials can be spared from war purs hope that we shall not have unemt here in Massachusetts because materials, which are physically in the United States, are unavailable by manufacturers as a result of legor administrative restrictions. The legislation vesting the priority power resident, which power of the Presilegated to the Chairman of the War on Board, is probably adequate to e flow of materials. But it may be for the Congress to make sure that nistration of the priority power by Production Board is directed effecward the speedy and smooth resumpivilian production. The War Pro Board should be expected to elimlimitation orders, the conservation d its allocation systems just as the needs of the war program per-

of their effects or plans for re nt, I foresee that these problems canceled contracts and securing es of raw materials for civilian prowill presently be matters of widencern here in Massachusetts.

marize, my specific recommendathat legislation should be enacted the following points:

MENT OF TERMINATED WAR CONTRACTS

erminated contracts should be setgotiation by the contracting agenhe Government, and the negotiated nt should be final in the absence or misrepresentation.

npt partial payments amounting to rge percentage of the claim should to each contractor upon submittal ed statement of the claim, subject, to a penalty for perjury.

settlement committees should be d to authorize partial payments delay of over 30 days occurs on the Government agency.

4. Contracting agencies should be required to give prompt clearance of claims on work in process. There should be clear-cut procedures for authorizing the removal of Government-owned inventories and machines, with storage at Government expense, in order that civilian production may be started.

5. The dilemma of the subcontractors must be resolved. At the present time the Government exercises the right of approving all payments in settlement of subcontracts but does not assume any responsibility to the subcontractor, with the result that the subcontractor in many cases cannot secure action by either the prime contractor or the contracting agency. I suggest that the local settlement committees proposed above should be empowered to approve settlement of subcontracts if a delay occurs in approval by the contracting agency.

B. DECONTROL OF MATERIALS

1. As soon as war conditions permit, the rules for the release of scarce raw materials should be revised with a view to facilitating the rapid resumption of civilian production.

A Magnificent Job

EXTENSION OF REMARKS
OF
HON. LOUIS LUDLOW
OF INDIANA
IN THE HOUSE OF REPRESENTATIVES
Tuesday, January 11, 1944

Mr. LUDLOW. Mr. Speaker, Indianapolis and Indiana are very proud of the great pharmaceutical house of Eli Lilly & Co., which has processed its millionth blood donation without a cent of profit. This record is in keeping with the fine, generous spirit which this firm always has manifested in the service of our country and which long ago brought to it the recognition of an Army-Navy E award. Commenting on the company's contribution to the blood campaign, which means so much in saving the lives of our precious boys, the Indianapolis News says editorially:

LILLY'S CONTRIBUTION

In the midst of charges that some concerns are making an unholy profit from war contracts it is heartening to learn that the Indianapolis laboratories of Eli Lilly & Co. have processed 1,000,000 blood donations entirely on a nonprofit basis.

In addition to performing this service at cost, the expense involved has been decreased constantly through the introduction of more efficient methods.

There certainly could have been nothing unethical if the Indianapolis pharmaceutical house had sought a minimum profit for the work it has been doing.

Donations of blood at Atlanta, Chicago, St. Louis, Detroit, Cincinnati, Louisville, Columbus and Indianapolis have been converted into live-saving plasma at the Lilly plant, involving the installation of new equipment and the employment of much additional skilled personnel.

The patriotic Americans who donated this blood, however, got nothing for their contributions and the Lilly Co. determined that its connection wiht the effort to strengthen the wounded on every fighting front should be entirely shorn of private gain. From beginning to end, it has been and is—a magnificent job.

The Gates Must Not Be Close

EXTENSION OF REMARK
OF
HON. SAMUEL DICKST
OF NEW YORK
IN THE HOUSE OF REPRESENT
Tuesday, January 11, 194

Mr. DICKSTEIN. Mr. Speake leave to extend my remarks in ORD, I include the following edito the Daily Mirror of January 4,

THE GATES MUST NOT BE CL

When Congress reconvenes on Ja it should take up the Gillette-Taft-Rogers resolution.

This resolution calls for the form a Presidential commission to create ery, in conjunction with the Unit tions, to rescue the millions of Je are now being systematically exter by the Nazis and their Quislings.

When the Presidential commission work, one of the first things it shoul to seek the abrogation of the Cha "White Paper" of May 1939.

At present, Palestine is being adm by Great Britain in conformity wit icy embodied in the "White Pape tue of which Jewish immigration i tine is now limited and is to be stopped after March 31, 1944. Th be reduced to a permanent m percent in the country and t id to Jews is to be practically p

A DIRECT REPUDIATION

is is a direct repudiation on pa of the League of Nations Man the Balfour Declaration incorporate mandate of 1917.

According to this declaration, Pale to become a national Jewish home u protectorate of England.

In 1921, after the Jews had create ern civilization in what was prac Arabian desert, England turned on her solemn promise of 1917.

This infidelity of Britain toward was denounced by no one more than by Winston Churchill in Parli the debate on the "White Paper" when he said:

MR. CHURCHILL'S REGRET

"As one intimately and responsi cerned in the earlier stages of our policy, I could not stand by and se engagements into which Britain ha before the world set aside for reaso ministrative convenience or for the quiet life. I should feel personally rassed in the most acute manner myself by silence or inaction to wha regard as an act of repudiation.

"I regret very much that the pledg Balfour Declaration, endorsed as it by successive governments, and th tions under which we obtained the have both been violated by the Gove proposals.

"I select one point upon which plainly a breach and repudiation of four Declaration—the provision tha immigration can be stopped in 5 ye by the decision of an Arab majority. a plain breach of a solemn obligation

As the Palestine Mandate was or the League of Nations, it cannot gated even by Great Britain herself the consent of the League.

A SOLEMN OBLIGATION

But the League did not give its co the 1939 abrogation.

SURGERY

VOL. 15 MARCH, 1944 NO. 3

Original Communications

ANTERIOR RESECTION FOR CARCINOMA LOW IN THE SIGMOID AND THE RECTOSIGMOID*

CLAUDE F. DIXON, M.D.,† ROCHESTER, MINN.

(From the Division of Surgery, Mayo Clinic)

I HAVE always considered it a great opportunity to attend the meetings of the Chicago Surgical Society. On this occasion honoring Dr. Bevan I feel even more deeply concerning the privilege. Moreover, I am truly mindful of the responsibility the acceptance of your invitation entails.

Certainly it is not from lack of respect for the great surgeon in whose memory this lectureship was founded that I shall omit the biographic and eulogistic remarks that would be appropriate on this occasion. Rather, my omission springs from an excess of respect for him. I would not imply, by reviewing the life of one so recently deceased, that his years of achievement thus soon could have passed from the memory of his colleagues. Nor would I attempt to recount his accomplishments before an audience, many members of which witnessed the development of his projects day by day. I hope, then, you will agree that I can best honor Dr. Bevan by applying immediately what ability I have and what time is accorded me this evening to present one aspect of that immense field of surgery in which he spent his life and wrought so well.

My subject, anterior resection of the lower part of the sigmoid and of the rectosigmoid for carcinoma, cannot be and is not mentioned with the idea that the procedure is a new one. I have, however, during the past several years performed the operation I am about to describe in the hope that I could re-establish the continuity of the bowel and thus obviate the necessity of making a permanent colonic stoma.

Received for publication, Oct. 20, 1943.

*The Bevan Lecture presented at a meeting of the Chicago Surgical Society, Chicago, Ill., Oct. 1, 1943.

†I wish to acknowledge the assistance of Drs. James L. Vadheim and R. E. Benson, Fellows in Surgery, of the Mayo Foundation, in the preparation of this lecture.

TECHNIQUE OF ANTERIOR RESECTION

A low left rectus incision is employed. The liver and upper abdominal viscera are carefully examined by palpation in an effort to determine the presence or absence of distant metastasis. Next the tumor itself is examined and if it is removable the resection is begun.

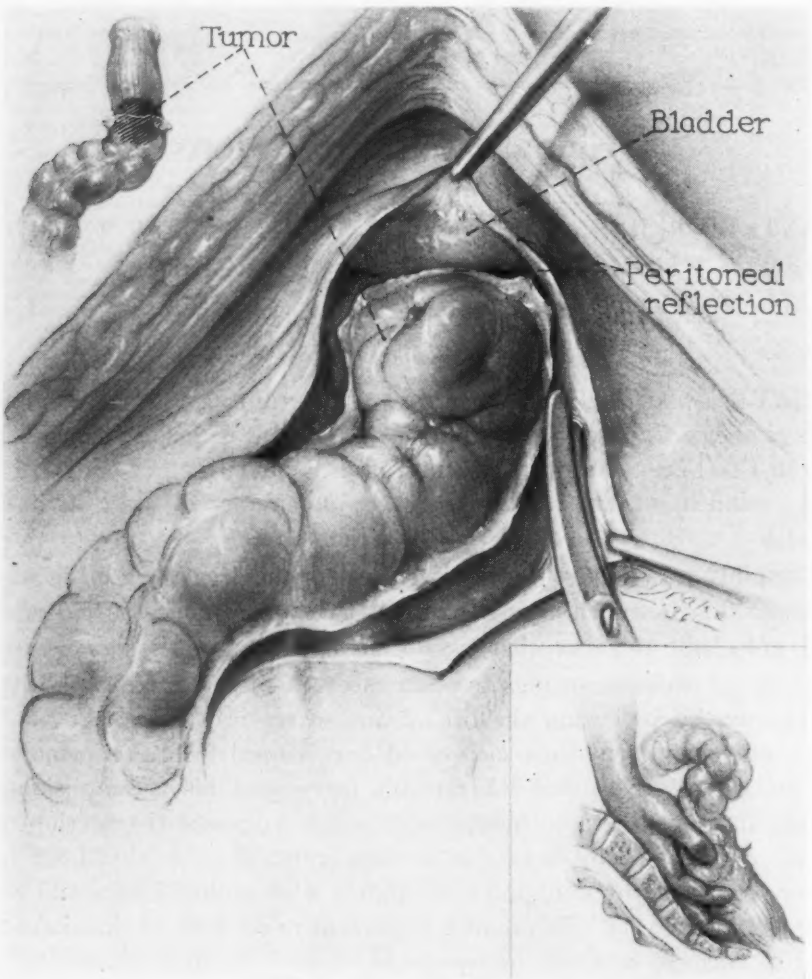


Fig. 1.—Situation of carcinoma to be removed by the technique described. The peritoneum is freed mesially and laterally as if a combined abdominoperineal operation were to be performed. Inset: Method of mobilizing the pelvic colon, upper part of rectum, and adjacent tissuses by passing the hand into the hollow of the sacrum. (From Dixon, C. F.,[2] Courtesy of Paul B. Hoeber, Inc.)

The patient is placed in the Trendelenburg position. The peritoneum of the pelvic portion of the colon is first freed from the lateral aspect of the bowel and then from its mesial aspect. After that the ureters are identified and isolated. The peritoneum is divided between the base of the bladder and the rectosigmoid in a male, or across the posterior aspect of the cervix in a female (Fig. 1), as if an abdominoperineal resection

were contemplated. Next the lateral and mesial aspects of the mesocolon of the pelvic portion of the colon are incised; the incisions are begun at the level of the origin of the superior hemorrhoidal artery. Following this the superior hemorrhoidal artery and vein are ligated and divided (Figs. 2 and 3).[2] Care must be exercised to insure that the ligature is placed distal to the origin of at least one of the sigmoidal arteries which arise from the inferior mesenteric artery. Henceforth the blood supply

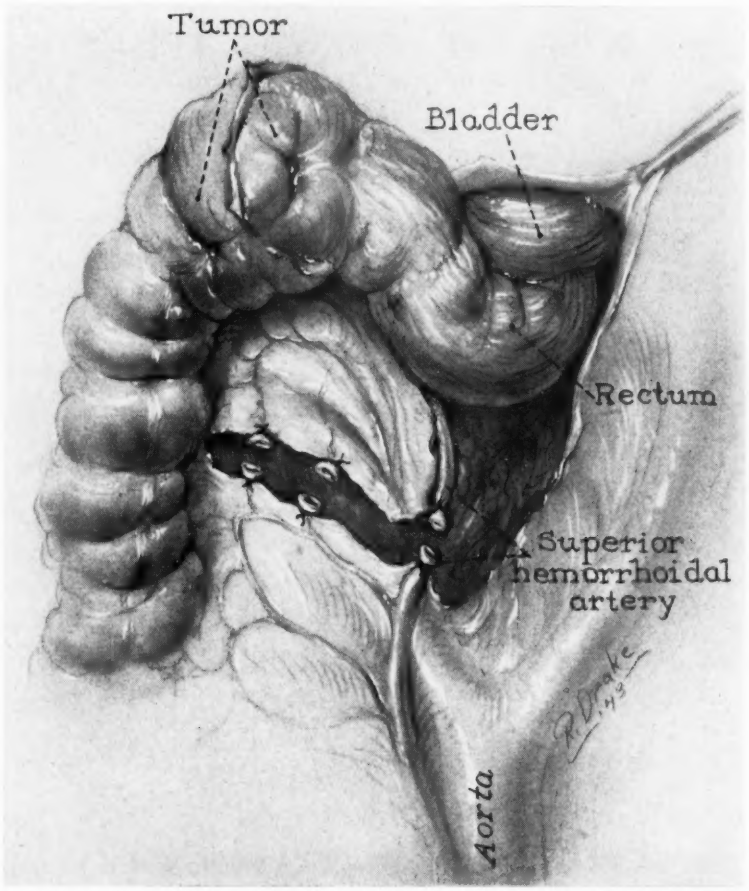


Fig. 2.—The superior hemorrhoidal artery has been ligated and mobilization of the lower pelvic part of the colon and upper portion of the rectum has been started.

to the rectosigmoid or rectum will come from the middle and inferior hemorrhoidal vessels. The blood supply to the portion of bowel which is to be the proximal segment is from the inferior mesenteric vessels through the sigmoidal or marginal arteries.

After the superior hemorrhoidal artery has been ligated and divided, the pelvic portion of the colon together with all of the adjacent tissue containing lymph nodes is mobilized by passing the hand into the hollow of the sacrum and lifting the structures as is shown in the inset in Fig. 1.

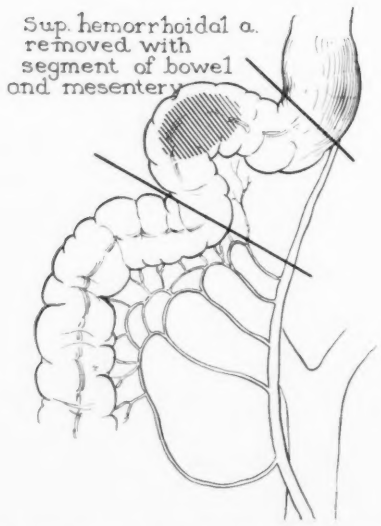


Fig. 3.—Ligation and division of the superior hemorrhoidal artery just distal to the point of emergence of the sigmoidal arteries and the segment of colon to be removed.

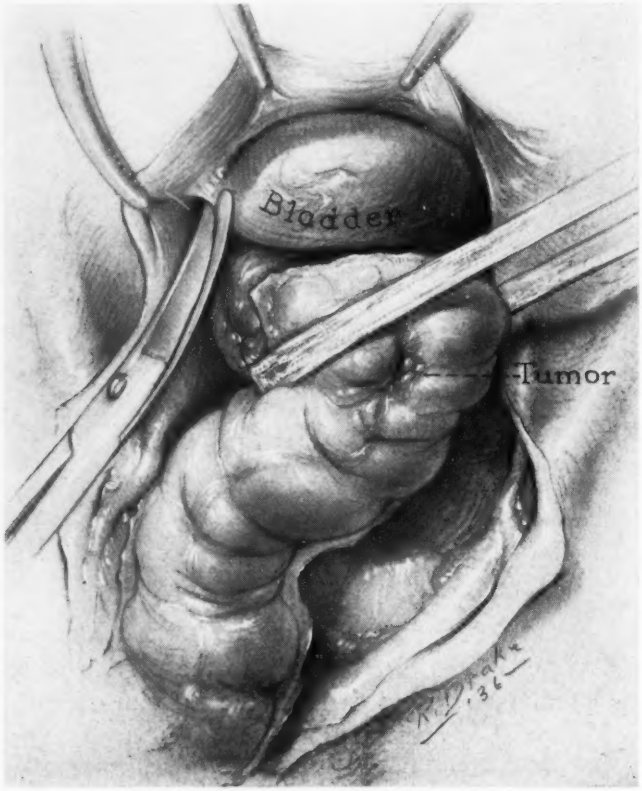


Fig. 4.—The portion of colon to be removed has been mobilized posteriorly and laterally and the ureter isolated and identified. The urinary bladder is dissected free and mobilized upward. (From Dixon, C. F.,[2] Courtesy of Paul B. Hoeber, Inc.)

By this procedure the rectosigmoid can be mobilized and about one-half of the rectum can be drawn up into the pelvis (Fig. 4). The entire segment of colon to be removed is now mobile. Rubber-guarded clamps are applied (Fig. 5). The intestine is resected from the pelvic portion of the sigmoid flexure to the upper part of the rectum and an end-to-end anastomosis is made between the first portion of the sigmoid flexure of the colon, or the lower part of the descending segment, and the rectosig-

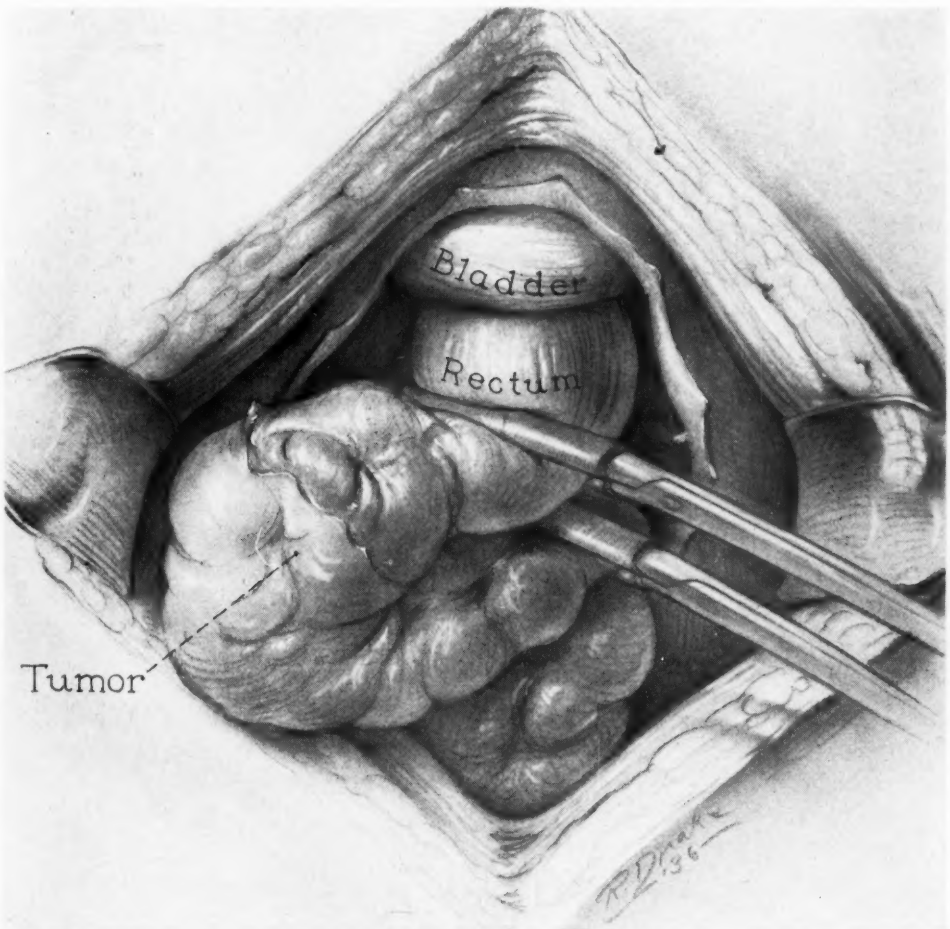


Fig. 5.—Rubber guarded clamps are placed at the points where amputation is to be made. (From Dixon, C. F.,[2] Courtesy of Paul B. Hoeber, Inc.)

moid or upper portion of the rectum (Fig. 6). Often it is necessary to sever the outer peritoneal attachment of the descending colon as high as the splenic flexure for the purpose of mobilization. In some cases it is difficult to approximate the two ends of bowel owing to an abnormal shortness of the lowermost sigmoidal artery. Fig. 7 illustrates how this technical difficulty can be overcome. By resecting the last sigmoidal artery and the small portion of the proximal end of bowel which is de-

pendent on it for its blood supply, the proximal and distal segments of bowel can often be brought into easy apposition.

After the anastomosis has been completed, 5 Gm. (75 gr.) of crystalline sulfathiazole are placed in the hollow of the sacrum and around the site of the anastomosis. A Penrose cigarette drain is inserted into the hollow of the sacrum and is brought out through the lower end of the abdominal incision. The peritoneum is then replaced immediately above the line of suture. The peritoneal leaves are approximated by

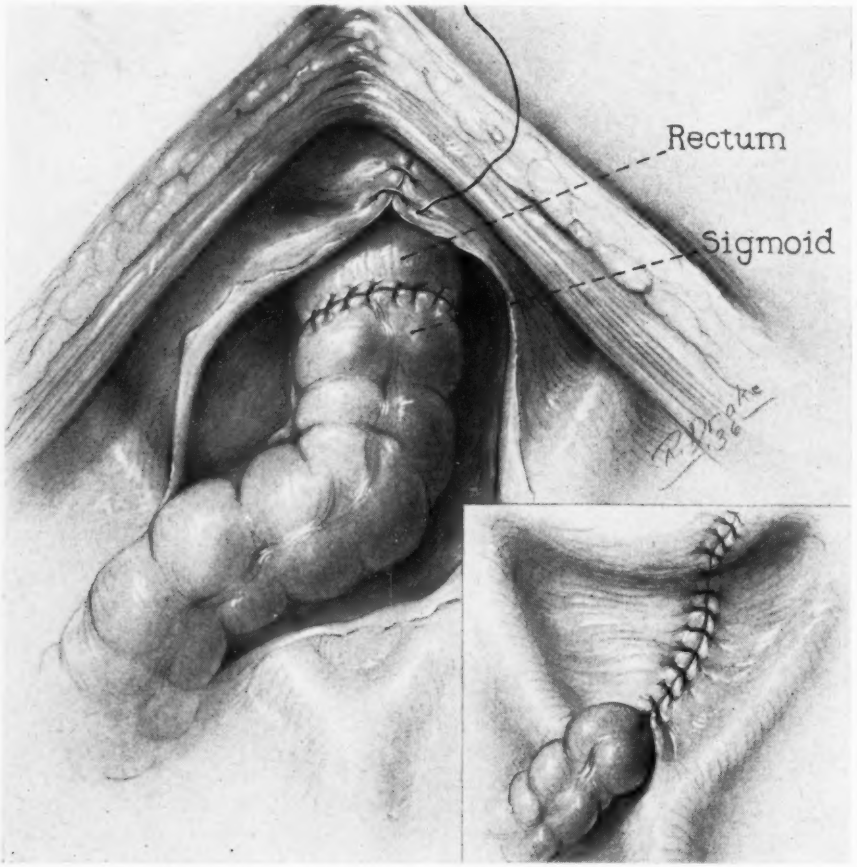


Fig. 6.—Completed anastomosis (end-to-end method) between the first portion of the sigmoid and upper part of the rectum. The pelvic peritoneum is approximated so that the anastomosis is extraperitoneal. (From Dixon, C. F.,[2] Courtesy of Paul B. Hoeber, Inc.)

suture to the lateral and mesial sides of the colon (which now occupy the pelvis) to form a reconstructed pelvic floor placed higher in the pelvis than normal.

Immediately after completing these procedures, a small upper midline abdominal incision is made, through which a knuckle of transverse colon is brought to the surface to permit a temporary colonic stoma to be provided. The primary incision then is closed in the usual manner and

also the secondary incision (usually only a few interrupted sutures of catgut are needed in the skin around the knuckle of bowel). Vaseline gauze is used for the purpose of sealing the upper abdominal incision around the knuckle of colon. Twenty-four hours later the portion of colon which was brought up into the midline incision is incised by means of the cautery. This colonic stoma may be closed three to six weeks later.

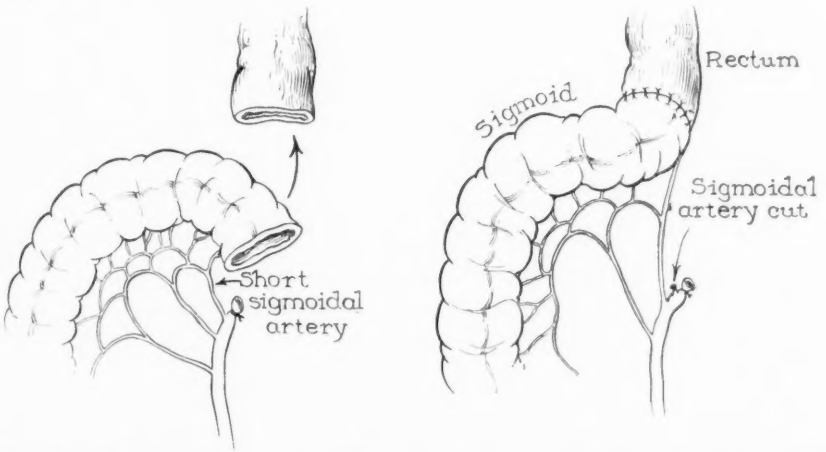


Fig. 7.—Method of overcoming difficulty in approximating the two ends of bowel due to abnormal shortness of the lowermost sigmoidal artery. The last sigmoidal artery and a small portion of the proximal end of bowel are resected thus allowing easy apposition of the two segments of intestine.

FACTORS OF IMPORTANCE TO ANTERIOR RESECTION

Formerly it was taught in some medical schools that ligation of the superior hemorrhoidal artery below the origin of the lowermost sigmoidal artery would compromise the blood supply of the rectosigmoid and upper part of the rectum so that necrosis of this portion of the bowel would result. The segment likely to become gangrenous was known as the critical point of Sudeck. It was reasoned that necrosis must occur because, it was believed, the marginal artery which courses parallel to the colon abruptly ends in the region of the lower sigmoid and does not anastomose with the blood supply from below. Logically, then, if the rectosigmoid depended on the marginal and superior hemorrhoidal arteries for its blood supply, and there could be no collateral circulation from below, this portion of the bowel would have to die. This may still appear to be true, but actually it is not. It can be definitely stated that the superior hemorrhoidal artery can be ligated and removed and even some of the marginal artery can be resected, as of necessity must be done in removing some of the lower left portion of the colon and the first portion of the sigmoid without significantly damaging the blood supply to the remaining portion of the descending colon, rectosigmoid or rectum. It is, in brief, safe to assume that all the colon which lies below the brim of the true pelvis will remain viable without the

marginal or superior hemorrhoidal arteries. The blood supply to this distal portion of bowel is adequately cared for in my experience by means of the middle and inferior hemorrhoidal arteries. I base this statement on experience in more than 200 anterior resections in which both the superior hemorrhoidal artery and a portion of the marginal artery were removed without any difficulty arising from inadequate blood supply to the distal segment of bowel.

A second fact which is equally important to the development of the technique of the operation must be mentioned. Simply stated, it is that carcinoma of the rectosigmoid and lower portion of the sigmoid does not ordinarily metastasize downward. Malignant lesions in this location almost invariably metastasize proximally to the mesenteric lymph nodes along the superior hemorrhoidal and inferior mesenteric arteries if spread of the disease occurs. This fact is as important as the first, for if such malignant lesions did metastasize to nodes below the growth it would be essential to good surgical treatment in all such cases to remove the rectum and perirectal glands and surrounding tissues. If such lesions do not metastasize downward, to remove the rectum for growths in the rectosigmoid and lower part of the sigmoid seems purposeless and adds unnecessary mutilation. Surgeons are indebted to Gilchrist and David, Coller, Kay, and MacIntyre and others for establishing this second basic fact.

Coller, Kay, and MacIntyre found in their studies no instance in which retrograde metastasis occurred to a significant level below the primary lesion. Grinnell concluded that downward lymphatic spread is exceedingly rare in operative specimens and only occurs by retrograde flow when the high nodes are blocked. Westhue stated in his report that in seventy-four cases he found only one instance of retrograde metastasis, and felt that this could be discarded as having no clinical significance. Gilchrist and David found retrograde metastasis to the level of 4 cm. below the primary lesion in two cases out of twenty-two. In both these instances, however, the lymph nodes above the growth in the bowel were completely blocked with carcinomatous cells. This, then, is the second fact, that carcinomas in the left lower portion of the colon do not tend to metastasize below the primary lesion to any significant extent.

RESECTABILITY

In the years, 1935 to 1941 inclusive, I operated on 243 persons who had malignant lesions in the rectosigmoid or low in the sigmoid. Of these, 200 (82 per cent) underwent a radical resection with the view to cure. On forty-three a simple exploration of the abdomen, some palliative procedure, or palliative resection was carried out. Of the 200 patients on whom resections of the colon with view to cure were performed anterior resections were employed in 120 and other types of radical

procedures, mostly exteriorization operations, in 80. I still use the exteriorization procedure whenever the lesion is high enough to make it possible. The resectability rate in my series for lesions in the rectosigmoid and low in the sigmoid, in general, then is 82 per cent.

RESULTS

The series on which I shall present results consists of 206 consecutive cases in which anterior resection was performed by me for carcinoma of the rectosigmoid or lower part of sigmoid, from the years 1930 to 1942 inclusive. These 206 cases are divided into (1) 181 cases in which anterior resection was carried out with a view of cure and (2) twenty-five cases in which the operation of anterior resection was done as a palliative procedure (Table I). I shall give the statistical results based on the 181 cases in which the operation was done as a curative procedure first and I shall consider the palliative resections later.

TABLE I

ANTERIOR RESECTION IN 206 CASES

ANTERIOR RESECTIONS	TOTAL CASES	PER CENT
With view to cure	181	87.9
Palliation only	25	12.1
Total	206	100.0

Operative Mortality After Anterior Resection With View to Cure.—Of 181 patients who underwent anterior resections with view to cure, twenty-two died during their stay in the hospital. A few of them died after closure of the colonic stoma, which is done in my cases as a secondary procedure. This gives an over-all hospital mortality, based on the total number of patients, of 12.1 per cent. During the years of 1930 to 1938, inclusive, in which I performed my first 100 anterior resections, there were eighteen hospital deaths, an operative mortality of 18 per cent. In the last eighty-one cases there have been four deaths (4.9 per cent). Over the course of the years the tendency has been for the hospital mortality to decrease (Table II). I believe that because of the advent of sulfonamides and other new chemotherapeutic agents I can now consistently perform this operation with a hospital mortality rate of less than 5 per cent.

TABLE II

OPERATIVE MORTALITY

INCLUSIVE YEARS	TOTAL CASES	HOSPITAL DEATHS	
		NUMBER	PER CENT
1930-1934	23	4	17.4
1935-1936	36	7	19.4
1937-1938	46	8	17.4
1939-1940	35	2	5.7
1941-1942	41	1	2.4
Total	181	22	12.1

Three-Year Survival Rates After Anterior Resections Performed With a View to Cure.—One hundred and four patients who underwent anterior resection with a view to cure, prior to Jan. 1, 1940, survived the operation and left the hospital. Of this number 102 were traced. Sixty (58.8 per cent) of the 102 patients traced were alive at the end of three years. If I include all the cases in which anterior resection was performed with view to cure prior to Jan. 1, 1940, whether the patients died in the hospital or not, the three-year survival rate becomes 49.1 per cent, that is 60 of 122 patients survived for three years or longer. The survival rate varies markedly according to the extent of the lesion found at the time of operation. Twenty-two (81.5 per cent) of twenty-seven patients who had carcinoma of type A (Duke's classification), 54.3 per cent of the patients who had carcinoma of type B, and only 44.5 per cent of those who had carcinoma of type C were alive at the end of three years or longer (Table III).

TABLE III

THREE-YEAR SURVIVAL RATES*

DUKE'S CLASSIFICATION	PATIENTS WHO SURVIVED OPERATION†		PATIENTS WHO LIVED 3 OR MORE YEARS AFTER OPERATION	
	TOTAL	TRACED	NUMBER	PER CENT TRACED
A	27	27	22	81.5
B	46	46	25	54.3
C	31	29	13	44.8
Total	104	102	60	58.8

*According to Duke's classification after anterior resection for malignant lesions of the rectosigmoid and lower part of the sigmoid colon.

†Inquiry as of Jan. 1, 1943. Included here are patients operated on three or more years prior to the time of inquiry, that is, 1939 or earlier. Hospital mortality is excluded in the calculation of survival rates.

I think it is only fair to note that of necessity these three-year survival rates are based on cases in which operations were performed prior to 1940. This means that all the cases in which I operated in the early years before I had the operation well standardized, and the operative, postoperative, and preoperative care well in hand are included in the present series. I think that the results are better in these cases at present. I know that the operative mortality has fallen rather markedly and I think that as the years have passed the tendency has been to perform more and more radical resections and that the survival rates have been improved thereby.

Palliative Anterior Resections.—Twenty-five out of 206 anterior resections were classified as palliative by virtue of the presence of metastatic lesions at the time of operation, which were irremovable and precluded the possibility of cure. Hepatic lesions which were characteristically malignant and of considerable size were the most common findings in this group. Cases in which the small nodules in the liver or masses did not feel absolutely characteristic of malignant lesions were not included in the group of cases of palliative resections. Implants in

the parietal or visceral peritoneum which were not removable were the second most important cause of palliative operations. Operations for carcinoma of the rectosigmoid and lower part of sigmoid which had infiltrated into surrounding structures such as the base of the bladder, uterus, ovaries, tubes, and so forth were not considered palliative if it was possible to remove all the grossly apparent carcinomatous tissues by resecting these organs along with the colon.

The operative mortality from these palliative resections is high. Eight out of twenty-five patients (32 per cent) died as a result of the operation. Of eighteen patients having operations on or before Jan. 1, 1940, none survived for three years. Several, however, lived for more than two years.

Before I began to perform palliative anterior resection in these cases, exploration or a palliative colostomy was the usual treatment. I do not know whether or not anterior resection is justified for this group, but I feel sure that all who survived the operation were more comfortable during their remaining days for having had this type of surgery performed.

COMMENT

The technique of radical anterior resection of the lower part of the sigmoid colon and rectosigmoid and re-establishment of continuity in the management of carcinoma low in the sigmoid or in the rectosigmoid which I have described has required time to perfect. Careful preoperative preparation has reduced the operative mortality rate from 19.4 to 2.4 per cent. During the twenty-four months prior to Jan. 1, 1943, such operations were carried out on forty-one patients with one death, or a 2.4 per cent mortality rate. This rate is figured on the basis of the number of patients and not on the number of operations performed on them.

My present opinion is that the results obtained following the procedure described compare favorably with those ensuing from other surgical methods employed in the radical removal of malignant lesions of the lower part of the sigmoid colon. The spread of carcinoma usually is upward. The superior hemorrhoidal vessels may be sacrificed without apparent impairment of the circulation to the rectosigmoid or rectum.

REFERENCES

1. Coller, F. A., Kay, E. B., and MacIntyre, R. S.: Regional Lymphatic Metatasis of Carcinoma of the Rectum, SURGERY **8**: 294-311, 1940.
2. Dixon, C. F.: Resection Without Permanent Colostomy for Carcinoma of the Rectosigmoid and Lower Portion of the Pelvic Colon. In Pack, G. T., and Livingston, E. M.: Treatment of Cancer and Allied Diseases, vol. 2, New York, Paul B. Hoeber, Inc., 1940, pp. 1414-1421.
3. Gilchrist, R. K., and David, V. C.: Lymphatic Spread of Carcinoma of the Rectum, Ann. Surg. **108**: 621-637, 1938.
4. Grinnell, R. S.: The Lymphatic and Venous Spread of Carcinoma of the Rectum, Ann. Surg. **116**: 200-216, 1942.
5. Westhue: Quoted by Colp, Ralph: Discussion. Ann. Surg. **108**: 638-640, 1938.

THE FIXATION OF SKIN GRAFTS BY THROMBIN-PLASMA ADHESION

FORREST YOUNG, M.D., F.A.C.S., AND BENEDICT V. FAVATA, M.D.
ROCHESTER, N. Y.

(From The Department of Surgery, The University of Rochester School of Medicine and Dentistry and the Strong Memorial Hospital)

AMONG the many factors which influence the take of free skin grafts one of the most important is accurate and complete fixation. This is true since survival of the graft depends upon the rapidity with which circulation is established. If the graft moves on the surface to which it is applied or if complete contact of the graft with the recipient bed is not continuously maintained then vascularization cannot take place.

Since contact and fixation may be defeated by movement of the graft, movement of the recipient area, or accumulation of fluid under the graft, the method of free graft application as used at present is designed to prevent these untoward events.[1] Movement of the graft is prevented by careful suture of the graft to the peripheral epithelial edges of the recipient area. On the extremities movement of the bed is prevented by splinting. On constantly moving parts such as the chest, which cannot be splinted, an attempt is made to have the graft and bed move in unison by holding it in place with an inlay form. But that this is not entirely efficient is shown by the smaller percentage of successful takes on chest and face than on the extremities. An attempt to prevent accumulation of fluid under the graft is made. This is done by perforating the graft so that fluid may escape, and by snug well-fitted compression dressings. Although fairly efficient in preventing serum accumulation under the graft, such a dressing is difficult to apply on irregular surfaces. If applied too tightly, spotty necrosis of the graft may result. The dressing must be left in place for four to five days until the graft is securely adherent.

One great objection to the entire method of accurate suture and compression dressing is that it is time consuming and must be carried out with great attention to detail to insure successful takes.

It is evident that this problem of keeping the graft in close contact with the bed is fundamental when one considers the manner in which a graft at first obtains nutrition and subsequently grows on the surface to be covered. The graft has been detached from the body and although the epithelial cells die slowly, as is shown by the fact that a skin graft when protected from drying can be kept viable for two weeks and longer by refrigeration, still the entire process of skin transplantation is a

Received for publication, Dec. 23, 1943.

race between the cellular degeneration of the graft and the establishment of vascular connections with the bed.

It is generally believed that during the first twelve to twenty-four hours there is an osmotic flow of plasma into the graft. Goldman[2] believed that the graft receives its first nourishment from this influx of leucocytes and lymph which he called "The plasmatic circulation." Davis and Traut,[3] from their experiments, also concluded that there is a stage of plasmatic circulation which probably plays an important role in the survival of the transplant. They pointed out that all workers agree that there is a migration of leucocytes and a flow of lymph into the graft. The length of time this osmotic process of graft nutrition operates is probably variable but there is evidence that it is the only means of nutrition for probably the first twenty-four to forty-eight hours. Davis and Traut state that the first new blood vessels are found in the graft between forty-eight to sixty hours after transfer. Red blood cells have been found as early as thirty-six hours after transfer. In twenty-two to seventy-two hours there are early anastomoses of small blood vessels between the graft and the bed. During this period the graft shows a degenerative process as well as active proliferation of the various elements, which gains impetus between the sixth and eighth days. According to Davis and Traut the balance between degeneration and proliferation depends on the status of the circulation of the transplant. By the fifth day there is regeneration of the various elements of the graft. In their experiments the graft resumed normal appearance in between fourteen to twenty days.

From personal observation of skin grafts of various types it has seemed to us that the one great factor in the failure of transplanted skin to remain viable is incomplete or transient contact of the graft and bed. This is so outstanding that while one approaches the grafting of a smooth, firm, immobile surface such as the forehead with complete confidence, the application of a free skin graft to a moving, yielding, possibly irregular surface such as the lip is always attended with some apprehension as to the ultimate viability of the entire graft. Failure of contact may result even when the graft is carefully sutured to the periphery of the defect. This failure of contact is often spotty in character and may be due to local hematoma formation, local serum collection, or the stretching of the graft across a depressed spot in the bed. If the bed is firm and smooth, these losses are usually minimal or absent since an even pressure can be efficiently exerted by appropriate dressings. The complete loss of a free skin transplant is unusual in the hands of surgeons experienced in this type of surgery, but it is not uncommon for the inexperienced or occasional operator. This is true because the absolute necessity of complete fixation contact of the graft and bed is not appreciated.

Another common factor in the failure of take of free skin grafts is that the graft applied has too great thickness, or possibly too great an area, for the vascularity of the bed in question. When it is remembered that the balance of degeneration and proliferation in a graft is delicate at 4 or 5 days, it can be seen that too tardy vascularization will result in ascendancy of the degenerative process. Thus, a full-thickness graft will rarely if ever take on a granulating surface. Full-thickness grafts when applied to fresh surgically made beds have a higher percentage of take when the graft is from a thin area such as the eyelid, groin, or inner surface of the upper arm. It is also common experience that small full-thickness grafts have a much higher percentage of take than full-thickness grafts of large square area, since in the smaller graft the circulation established around the periphery is relatively of more importance. In general, the thinner the graft the higher percentage of success. It is rarely possible to transfer subcutaneous tissue with the skin, since the thickness is so great that vascularization does not readily or quickly occur.

In brief, the survival of a free skin transplant depends upon speedy vascularization. At present this is provided for by selection of thin grafts and the attempt to maintain uninterrupted contact of bed and graft by mechanical pressure.

Now, it is well known that if a small skin graft is placed on a granulating surface and can be protected from being dislodged, it will grow. In fact this was the original Reverdin contribution. Such a graft does become more or less adherent due to the drying of plasma which exudes from the granulating surface but is easily dislodged until invaded by capillaries.

On a fresh surface the situation is quite different. Here the normal process of healing occurs, leucocytes and red cells are extravasated, a fibrin meshwork is formed through the cellular material, and with the formation of the clot, serum is squeezed out. If the graft is merely placed on the surface, serum accumulates under it. The capillaries must grow through the fibrinous cellular clot and serum to reach the graft. This process of vascularization takes too long and the graft dies. It is probably this sequence of events which caused surgeons for a good many years to apply grafts only to granulating surfaces. When an attempt is made to prevent this normal healing process of clot formation by absolute hemostasis and hence keep the graft and bed in contact, then it is probable, since the cellular material is minimal, that little thrombin is liberated and hence fibrin formation small. Thus the graft does not become biologically adherent and must be held in contact by pressure until capillary invasion occurs. The capillaries use the fibrin meshwork as a scaffold along which the cells grow and if the scaffold is scanty, vascularization is retarded.

Ideally, it would seem that for vascularization of a graft to occur as speedily as possible it should be biologically adherent to the bed at once. Theoretically this adherence should be of such a nature that it corresponds to the stage of wound healing just as the cellular debris is removed, and only the fibrin scaffold remains over which the fibroblast carrying capillaries could grow at once.

With these thoughts in mind we attempted to produce a preparation that would cause a graft to adhere to its bed, furnish nutrition as early as possible, and afford an eschar to protect the surface. After following several leads on dogs, the simplest, most efficient and theoretically most ideal method seemed to be the precipitation of fibrin between bed and graft by the addition of thrombin to plasma.

There have been few attempts to solve this problem. Whipple[5] reported that he had seen cases in which, after a granulating surface was frosted with an ultramicroscopic form of sodium sulfadiazine, grafts stuck and took well. This was an attempt to control infection, which is another cause of graft loss on granulations. Sano[4] advocated the use of plasma and an extract of the cellular elements of the blood. This was an attempt to produce a biologic adherence of the graft. The plasma and cellular extract were prepared autogenously in each instance. Because of this the method was cumbersome and although its successful use has been reported, a simpler more widely usable method would be preferable.

Although only autogenous skin grafts take permanently, it seemed to us that since pooled plasma is used without reaction and since thrombin is probably a definite chemical compound, there was no necessity of these materials being autogenous, and such has been our experience. In our animal experiments, autogenous skin grafts were successfully applied on dogs using human plasma and rabbit thrombin as the source of fibrin fixation.

There is a considerable amount of facts known about the properties of thrombin. It was first prepared in 1933 by Mellanby.[6] He demonstrated some of its properties and among these noted that the time required to coagulate plasma is inversely proportional to the amount of thrombase added. Whatever quantity is used, practically all of the thrombase disappears after fibrin is formed. This is of importance since Lozner and co-workers[9] showed that parenteral administration of thrombin is very toxic and results in generalized thrombosis. This would seem to be less likely to occur from the application of thrombin to a wound surface.

It is nontoxic when used in ordinary amounts as a hemostatic agent. In this respect it is quite efficient. Seegers and associates[8] showed that 1 c.c. of a 1 per cent solution will clot 1 c.c. of blood in two seconds. One part of purified dry powdered rabbit thrombin to 60,000 parts of a 0.25 per cent citrated blood results in coagulation in three seconds.

Thrombin can be used as a powder on open wounds without toxic effects. It has recently been used as a hemostatic agent in brain surgery.[10]

It would appear from the evidence cited that the only toxic effect that could occur from the application of thrombin to a wound surface would be its accidental introduction in comparatively large amounts into an open vein. This has not been reported from its use as a hemostatic agent and would seem still less likely when used in conjunction with plasma due to its almost complete and immediate inactivation.

Purified thrombin does not contain fibrinolysin.[7] Hence, the precipitated fibrin forms a stable clot which remains long enough for our purposes when added to plasma. It is a carbohydrate containing protein. It is highly soluble in water and in 0.9 per cent sodium chloride solution. A low concentration of many of the salts does not cause the precipitation of thrombin. It can therefore be dissolved in normal saline solution and may be made into any desired concentration.

METHOD

Any type of free graft may be applied. Reverdin, Davis deep grafts, Thiersch, split-thickness, dermatome, or full-thickness skin grafts may be used. The selection of one or the other should depend upon the character and extent of the wound, the availability of skin, and the ultimate result desired.

If the recipient site is a granulating surface, no preparation is necessary other than the mechanical removal of crusts and dead epidermis at the periphery. If the site to be grafted is a fresh surgical wound, hemostasis is carefully carried out. In traumatic wounds, dead and devitalized tissue should be removed and the accepted principles of wound care followed.[11]

The bed to receive the graft is flushed with stock plasma. Excess is to be avoided, since as fibrin is formed the fluid portion of the plasma remains. The desired grafts are removed. They should not be placed in saline solution or washed in any way since this removes the small amount of natural cohesive agents present. (It has long been noted that grafts seem to adhere and take better if this detail is considered.[12]) The undersurface of the graft is wet with thrombin solution. The graft is quickly applied and adjusted into the desired position. It is lightly pressed in place and so maintained for a few seconds. The graft will rapidly adhere to the wound following its every contour. As fibrin forms, clear watery fluid is squeezed out. Some of this escapes from under the graft; some is undoubtedly trapped under the graft. However, as this fluid is essentially an electrolyte solution of physiologic concentration it is probably rapidly absorbed. We have not observed any ill effects from not making openings in the graft to allow its escape and thus far have not considered this necessary. It may be that the fluid is of value in the early nutrition of the transplant.

The graft becomes so firmly adherent within a few minutes that it will wrinkle and move as normal integument when surrounding parts are moved. In one instance where a split-thickness graft was used to cover a traumatic loss on the dorsum of the hand, the graft within a few minutes would glide over the underlying structures in normal fashion when the fingers were flexed and extended.

The graft becomes so firmly fixed that sutures, splinting, or retentive dressings are unnecessary. The grafted wound may be left open since a dry eschar at once forms around its edge. A light dressing may be applied merely to protect the area from the bedclothes; it is better dispensed with.

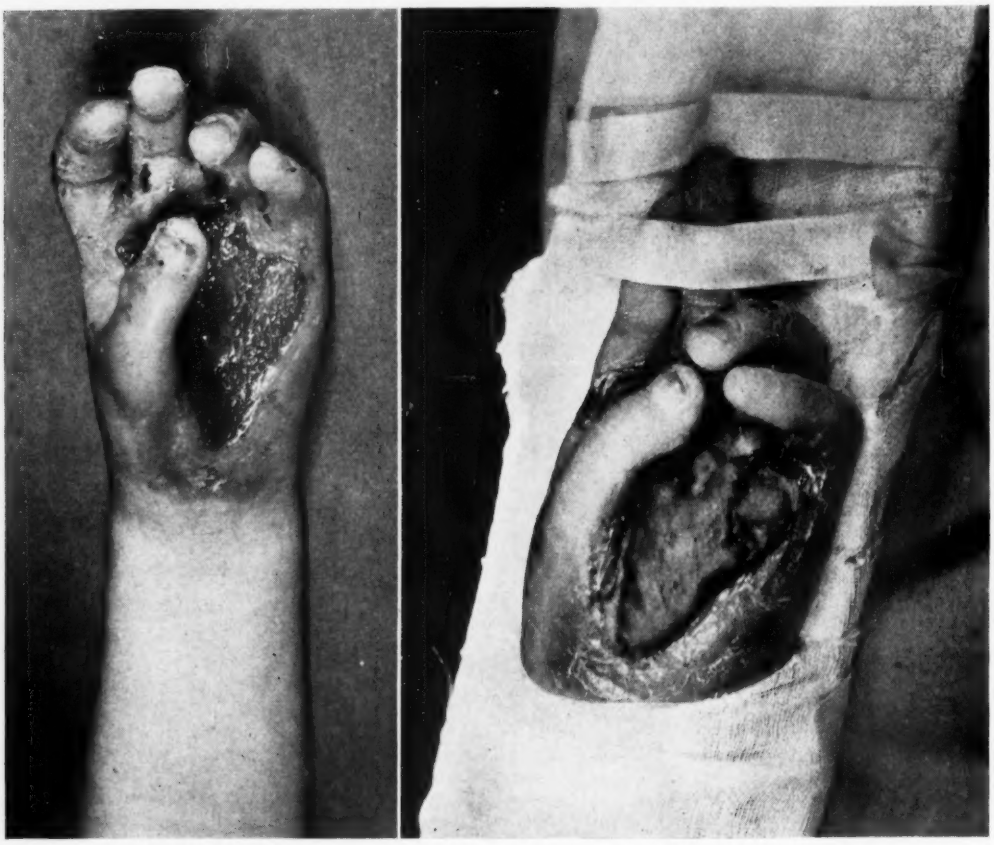
Fig. 1.—Dorsal skin of hand avulsed in wringer exposing one extensor tendon. Split-thickness graft applied immediately after débridement; no sutures or compression. Graft securely adherent in thirty seconds after thrombin-plasma application. Wrist splinted because of senility and lack of cooperation. Photograph shows 100 per cent take on third postoperative day.

It would seem that the interlacing mesh of fibrin affords better nutrition for the graft. This may be due to either the presence of the fluid remains of the plasma, easier osmosis, or the more rapid ingrowth of capillaries.

That the graft becomes more quickly vascularized than as previously applied is quite striking. The graft surface remains normal in texture. Within twenty-four hours a split-thickness graft becomes pink and within forty-eight to seventy-two hours it will blanch on pressure and quickly recover its pink color, indicating an adequate circulation. We have not yet seen a split-thickness skin graft go through the intermedi-

ate cyanotic stage commonly observed at three to five days. This would indicate that the process of graft degeneration does not become ascendant and that the cells probably have their normal metabolism little disturbed.

The plasma we have used has been the stock pooled plasma from our plasma bank. This is prepared from a mixture of 50 c.c. of a 5 per cent sodium citrate solution and 500 c.c. of whole blood. As a matter of convenience we have packaged 5 c.c. of plasma in pyrex tubes sealed with



A. *B.*

Fig. 2.—*A*, Granulating wound of palm of hand from wringer injury. All flexor tendons have sloughed and cartilage of two metacarpophalangeal joints is exposed. *B*, Plasma-thrombin adhesion, 100 per cent take of split-thickness graft applied without suture or compression. The graft lived over the areas of exposed cartilage which were about 1 cm. square. Hand was splinted because the patient was a 4-year-old child.

rubber stoppers. A sufficient number of these are kept frozen in the plasma bank so that a considerable number are immediately available. These small amounts of plasma are all that are ordinarily required in applying a graft of considerable size. The small containers prevent waste and reduce cost. The tube is obtained and thawed by the operating room nurse as part of the regular equipment obtained for any skin

grafting procedure. Dried plasma may be kept in small vials ready for instant use.

Thrombin (prepared by Seeger's method)* is prepared as a wafer sealed in a sterile glass ampule. These ampules are designated as 10,000 units. If 250 units are dissolved in 10 c.c. of saline, one part of the resulting solution of thrombin when added to four parts of plasma in a test tube produces a fibrin clot in thirty-five seconds. We divide the 10,000 units of powdered thrombin into ten parts and place each into a sterile vial. From this, dilutions are made as needed so that small glass tubes containing 250 units in 10 c.c. of solution can be kept on hand. These are kept in an ordinary refrigerator and will maintain their potency for one to two weeks. The strength of the solution can always be checked against a known amount of plasma and the time for clot to form noted. When thrombin is put on the market it would simplify its use for skin grafting and wound suture if it were put up in amounts of 250 to 500 units per ampule. The solution could then be made as needed without waste.

SUMMARY

The survival of free skin graft depends upon early vascularization. In order for this to occur the transplant must be held in complete continuous contact with the surface on which it is applied.

This can be accomplished by the precipitation of fibrin between graft and bed by adding thrombin to plasma. The rate of fibrin formation can be adjusted to any speed desired by increasing or decreasing the concentration of the thrombin solution.

This method has decided advantages. It takes little time as compared to the suture-compression dressing method. It seems to allow vascularization from three to four days earlier than former methods. It is practical, since plasma and thrombin can be stored in refrigerator and be ready for use at all times.

We believe a much higher percentage of take is obtained.

The precipitation of fibrin as a binding agent on wound surfaces would seem to have many obvious uses in surgery. At present we are investigating its usefulness in obliterating dead space between extensive raw surfaces such as result from radical mastectomy, as the sole suture material for lacerations of the face, and in the closure of subcutaneous tissues and skin in abdominal surgery. Its usefulness in these fields will be reported.

We wish to express our appreciation to Joseph W. Howland, M.D., for his valuable suggestions and criticisms concerning the preparation and use of thrombin.

REFERENCES

1. Byars, Louis T.: Free Full Thickness Skin Grafts, Surg., Gynec. & Obst. **75**: 8-20, 1942.

*Supplied to us for investigational purposes by Parke, Davis & Co.

2. Goldman, E. E.: Ueber das Schicksal der nach dem Verfahren Von Thiersch Verpflantzen Hautstueckchen, Beitr. z. klin. Chir. **2**: 229, 1893-94.
3. Davis, John Staige, and Traut, Herbert F.: Origin and Development of the Blood Supply of Whole Thickness Skin Grafts, Ann. Surg. **82**: 871-879, 1925.
4. Sano, Machteld E.: A Coagulum Contact Method of Skin Grafting as Applied to Human Grafts, Surg., Gynec. & Obst. **77**: 510-513, 1943.
5. Whipple, Allen O.: Basic Principles in the Treatment of Thermal Burns, Ann. Surg. **118**: 187-192, 1943.
6. Mellanby, John: Thrombase: Its Preparation and Properties, Proc. Roy. Soc., London, s. B. **113**: 93-106, 1933.
7. Seegers, W. H.: Purification of Prothrombin and Thrombin. Chemical Properties of Purified Preparations, J. Biol. Chem. **136**: 103-111, 1940.
8. Seegers, W. H., Warner, E. D., Brinkhaus, K. M., and Smith, H. P.: The Use of Purified Thrombin as a Hemostatic Agent, Science **89**: 66, 1939.
9. Lozner, E. L., MacDonald, H., Finland, M., and Taylor, H. L.: The Use of Rabbit Thrombin as a Local Hemostatic Agent, Am. J. M. Sc. **202**: 593-598, 1941.
10. Putman, Tracy J.: The Use of Thrombin on Soluble Cellose in Neurosurgery, Ann. Surg. **118**: 127-129, 1943.
11. Young, Forrest: The Care of Soft Tissue Injuries, New York State J. Med. **43**: 1521-26, 1943.
12. Padgett, E. C.: Skin Grafting, Springfield, Ill., 1942, Charles C. Thomas, Publisher.

NOTES ON THE DIAGNOSIS OF HERNIATED NUCLEUS PULPOSUS IN THE LOWER LUMBAR REGION

R. Glen Spurling, M.D.,* and T. Campbell Thompson, M.D.*
Washington, D. C.

(From the Sections of Neurosurgery and Orthopedic Surgery, Walter Reed General Hospital)

ALTHOUGH accurate statistics will probably never be available, pain in the back in probably one of the most common human ailments. The problem is no less important in Army medicine than in civilian practice, for apparently backache is no respecter of age or of physical fitness. The soldier who is incapacitated with low back pain must be cared for in the Army if it is the result of military service. If there is a history of low back disability prior to induction, the soldier is generally returned to civil life without treatment. In any event, the problem of restoring these men to useful activities is a responsibility of the medical profession.

The purpose of this report is to discuss the role of the lumbar intervertebral discs in the larger problem of low back pain. We are fully aware that disc pathology is responsible for symptoms in only a small percentage of patients with lame backs, yet this lesion should always be considered in a differential diagnosis. Furthermore, the clinical manifestations of lumbar intervertebral disc lesions are, as a rule, sufficiently clear-cut that reasonably accurate diagnoses can be made in most cases on clinical findings alone.

HISTORY

In almost every instance of traumatic lesions of the lumbar intervertebral discs, the first symptom is backache. Only about 40 per cent of the patients give an unequivocal history of trauma precipitating the first attack. The usual history is "when in a bent forward position, lifting a heavy object, a sudden catch is felt in the back and straightening upright can be accomplished only with excruciating pain." The outstanding characteristic of the back pain is its mechanical nature.

Some patients will fall to the ground with severe pain; in others the pain begins mildly and gradually increases until each movement of the back produces discomfort. Relief of pain is usually obtained by lying still in bed for an hour or more. Some patients state that comfort is obtained only in a sitting position and a few even learn to sleep in a chair. So long as the pain persists it is intensified by bending or lifting.

Illustrations and certain portions of text reproduced by courtesy of the Army Medical Bulletin.

Received for publication, Oct. 19, 1943.

*Lt. Col., Medical Corps, Army U. S.

Strangely enough, some patients get relief from manipulation while others are relieved by complete immobilization.

Backache without radiation of pain into either leg is seldom caused by herniation of the nucleus pulposus. There is reason to believe that the lumbago associated with intervertebral disc lesions is caused by stimulation of the sensory nerve ending in the posterior annulus fibrosis and the posterior longitudinal ligament.

There may be one or more attacks of backache before the onset of sciatic pain. However, where trauma produces gross injury to the intervertebral disc, the leg pain may occur simultaneously with the low back disability. When the nucleus pulposus herniates through a tear in the annulus fibrosis, the intraspinal mass thus formed may impinge upon one or more components of the lumbosacral plexus with the production of sciatic pain. Pain is usually present along the entire course of the sciatic nerve. The points of maximum intensity are the gluteal region, the posterior thigh, and the lateral aspect of the leg or ankle. The gluteal region is the area to which the pain produced or intensified by coughing, straining, or sneezing is referred. Usually the sciatic pain remains unilateral but there are instances of bilateral pain, and not infrequently the pain will shift from one leg to the other during successive episodes.

Partial or complete remissions of symptoms occur characteristically in lumbar herniations of the nucleus pulposus. Recurrent attacks with freedom from pain between attacks is the usual history.

A patient with severe sciatic pain usually keeps the knee flexed; it is hard for him to get his heel to the floor. For this reason elevation of the heel of the shoe sometimes gives relief. Slight flexion of the knee and thigh gives relief of pain by relaxing the pull on the sciatic nerve. Any bending movement, sitting, or exercising exaggerates the pain.

Some patients report that certain parts of the leg are numb, or that certain parts of the leg or foot have a feeling of "needles and pins." An observing patient may describe his sensory involvement so accurately that a localizing diagnosis may be made. The pain is usually burning, stinging, or prickling and, in some instances, there is tingling and a feeling of electric shocks. For an accurate description of the dermatomes of the fifth lumbar and first and second sacral nerves, an anatomic textbook should be consulted. As a rough working basis it may be stated that the fifth lumbar dermatome is represented on the top and mesial side of the great toe and a small strip extending up the shinbone. The first sacral dermatome includes the dorsum of the foot, the four lateral toes, and a band about two inches wide extending up the lateral aspect of the leg to the knee. The second sacral dermatome extends posteriorly over the calf and the lateral aspect of the ankle and foot (Fig. 1).*

*Drawings by Cornelia T. Thompson.

A herniated nucleus pulposus at the fourth lumbar interspace, i.e., between the fourth and fifth lumbar vertebrae, causes sensory disturbances primarily in the fifth lumbar dermatome. The same lesion at the lumbosacral disc (the fifth lumbar interspace) causes sensory disturbances in the first sacral and perhaps the second sacral dermatome. A large lesion at either level may involve one, two, or three dermatomes.

Fig. 1.—Approximate sensory distribution of *L-5* (fifth lumbar), *S-1* (first sacral), and *S-2* (second sacral dermatomes).

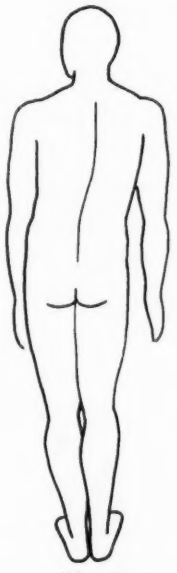


Fig. 2.

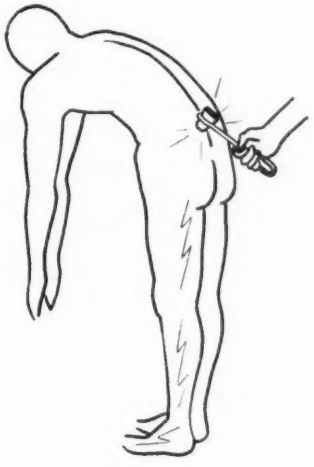


Fig. 3.

Fig. 2.—Typical list from lumbar disc lesion (left).
Fig. 3.—Production of radicular pain by deep percussion.

No "low back" record is complete without a thorough general medical history, particularly with respect to symptoms of rheumatoid arthritis and acute or chronic systemic infections. A mimeographed "low back" form is a great convenience in recording the essential features of the history and physical examination. The one used at Walter Reed General Hospital is shown in Tables I and II.

TABLE I

FRONT OF "LOW BACK" FORM

Register No. _____WALTER REED GENERAL HOSPITAL Date _____

NAME _____ RANK _____ STATION _____

Line of Duty_____Yes_____No_____

Date of Onset _____ Trauma _____

HISTORY

Back Pain: Location _____

Duration (number of months) _____

Intensified by Bending_____ Lifting_____ Coughing_____Straining_____

Relieved by Lying Down _____ Immobilization (Type) _____

Leg Pain: Onset (describe) _____

Pattern: Radiation to Hip_____ Knee_____ Calf_____ Foot_____

Intensified by Coughing_____ Straining_____ Bending_____ Sitting_____

Relieved by Lying Down _____ Flexing Thigh _____

Sensory Disturbances:

Numbness _____

Tingling _____

ADDITIONAL HISTORY: _____

_____

EXAMINATION

The examination should be made with the patient disrobed. Observations with respect to the posture, gait, general alignment of the legs with the trunk, position of the feet, and the motion of the small joints should be made. A careful evaluation of the patient as an individual (i.e., his general appearance, his mental attitude, and his overall personality) is of prime importance, particularly if operation is contemplated.

Most patients with a herniated nucleus pulposus have a straight lumbar spine with obliteration or reversal of the normal lumbar lordosis. Most of them, in addition, show listing away from the side of the sciatic pain (Fig. 2). In almost every instance the pelvis on the affected side is higher than on the unaffected side. Movements of the lumbar spine are usually limited, especially in flexion. Extension of the spine is often painful. The erector spinae muscles may be spastic and the spasm may be greatest on the side opposite the lesion. Light percussion or pressure at the level of the lesion will usually demonstrate an area of localized tenderness. Deeper percussion just to the side of this tender area may cause radiating pain into the gluteal region or leg (Fig. 3). Radiating percussion pains thus produced are caused probably by waves of force transmitted through the ligamentum flavum to the affected nerve roots

TABLE II

BACK OF "LOW BACK" FORM

EXAMINATION

Back: Lumbar Lordosis _____ Muscle Spasm _____

List _____ Right _____ Left _____ Pelvic Tilt _____

Percussion Tenderness _____

Radiating Percussion Pain _____

Lateral Bending Test: 1. Toward Painful Side _____

2. Away from Painful Side _____

Hyperextension Test _____

Leg: Sensory Changes: Hypesthesia _____

Paresthesias _____

Motor changes: Weakness _____ Atrophy _____

Reflexes Right _____ Right _____

Knee Jerks: Ankle Jerks:

Left _____ Left _____

Right _____°

Straight Leg Raising Test: Lasègue Test _____

Left _____°

Jugular Compression Test _____

Length of Extremities (A.S.S.-Ankle): Right _____ Left _____

X-RAY REPORT

_____

_____

RECTAL EXAMINATION

_____

_____

SEROLOGY

_____

CLINICAL DIAGNOSIS

_____

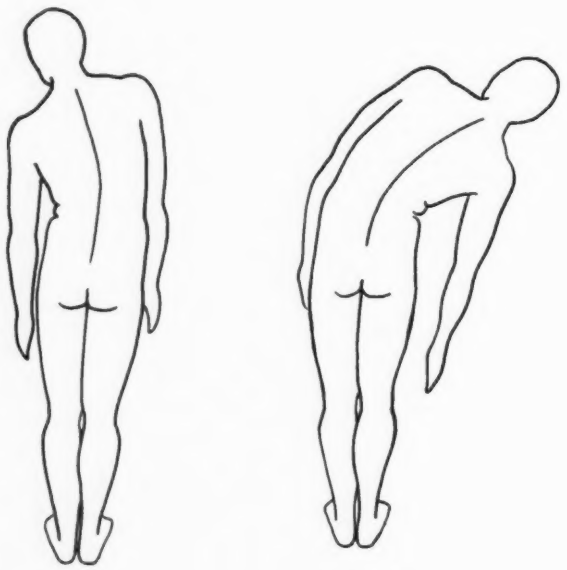
_____

at the site of the lesion. When positive, this sign is almost pathognomonic of a heriation of the nucleus pulposus.

Lateral bending is often restricted, particularly toward the painful side. Bending forcibly toward the painful side for thirty to sixty seconds usually intensifies the back pain and may reproduce the whole pattern of leg pain, even the sensory disturbances (Fig. 4*A*). Bending away from the painful side usually gives relief (Fig. 4*B*). Not infrequently a patient is observed who obtains relief by bending toward the painful side. Occasionally one is encountered who has alternating sco-

liosis. A herniation of the nucleus pulposus protruding near the midline should be suspected in such cases.

In testing for sensory changes, the patient must be relaxed and fully cooperative. Two forms of stimuli are sufficient to demonstrate gross sensory involvement—light touch with the finger tips and painful sensation with pinprick. In mapping out areas of sensory loss it is desirable to compare the normal with the abnormal side. In many instances the only sign of sensory disturbance will be the patient's statement that the skin of the involved area feels thicker than normal. In questionable cases, testing with heat and cold will demonstrate sensory loss when other tests are equivocal.



A. *B.*

Fig. 4.—*A*, Restricted lateral bending toward painful side. *B*, Unrestricted lateral bending toward normal side.

Paresthesias may be described as peculiar sensations (electric shocks) spreading from the point of stimulation into the remainder of the involved dermatome. They are best reproduced by lightly stroking the skin with the finger tips.

Patients in great pain cannot exert maximum muscular effort. For this reason weakness of the gluteal and hamstring muscles is difficult to demonstrate. Some muscular weakness is probably present when the fourth or fifth and first or second sacral nerve roots are compressed to any degree by a herniated nucleus pulposus. The anterior tibial, the peroneal and the long digital extensor muscles are involved most frequently. Atrophy occurs both from disuse and from focal paralysis of nerves, particularly in cases of long standing. Fibrillation of the regional muscles occurs in certain cases. Gross paralysis or bladder dis-

turbances are rare and when they occur the lesion is more likely to be a neoplasm of the cauda equina.

Diminution or absence of the ankle jerk on the affected side occurs in at least 80 per cent of herniations at the lumbosacral disc, but in only 25 per cent of herniations at the fourth lumbar disc (Fig. 5). These changes in the ankle jerks, coupled with maximal sensory findings, are valuable in localization of the lesion. The knee jerks are seldom involved with herniations at the fourth or the fifth lumbar disc. However, with herniations at the third lumbar disc, diminution or absence of the knee jerk is to be expected due to involvement of the fourth lumbar nerve root.

Fig. 5.—Recommended position for testing Achilles reflexes.

The straight leg-raising test is a valuable index of the degree of sciatic pain (Fig. 6). The angle at which pain appears may also be used as a reliable index for judging the progress of the case. The Lasègue's test is a useful refinement in equivocal cases (Fig. 7). These two tests are almost always positive in lumbar herniation of the nucleus pulposus producing sciatic pain.

Hyperextension of the lumbar spine usually greatly exaggerates the back and leg pain (Fig. 8). In this position, not only may the pain be exaggerated but the whole pattern of sensory disturbances in the leg may appear. When the *nonpainful thigh* is flexed upon the abdomen, relief of pain in the affected leg is experienced (Fig. 9). This test, when positive, is confirmatory evidence of a lumbar herniation of the nucleus pulposus.

The *jugular compression test* is performed by impeding the venous return from the internal and external jugular veins with digital com-

pression or with the cuff of a sphygmomanometer placed around the patient's neck. By increasing the intracranial pressure and consequently increasing the intraspinal pressure, the radicular pain in the affected leg is aggravated (Fig. 10). A positive jugular compression test is

Fig. 6.—Recommended position for straight leg-raising test.

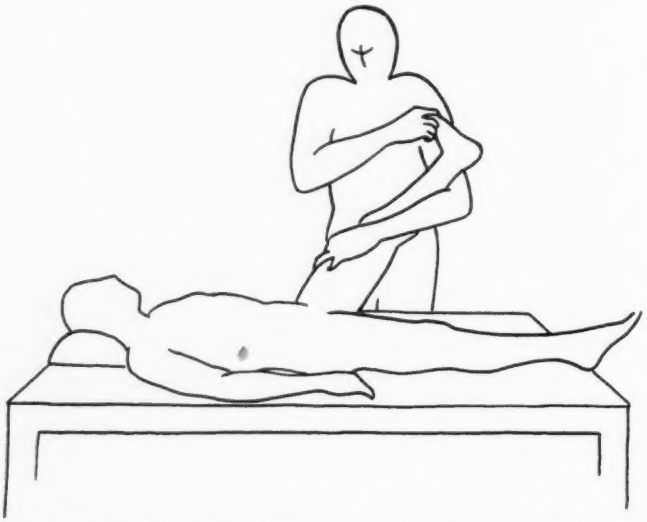


Fig. 7.—Lasègue's modification of straight leg-raising test.

pathognomonic of an intraspinal lesion, and when the pattern of the patient's leg pain is reproduced accurately the test is of great value in localizing the lesion.

LOCALIZATION OF THE LEVEL OF HERNIATION

Many lumbar herniations of the nucleus pulposus can be accurately localized on the basis of clinical findings alone. All cases have in com-

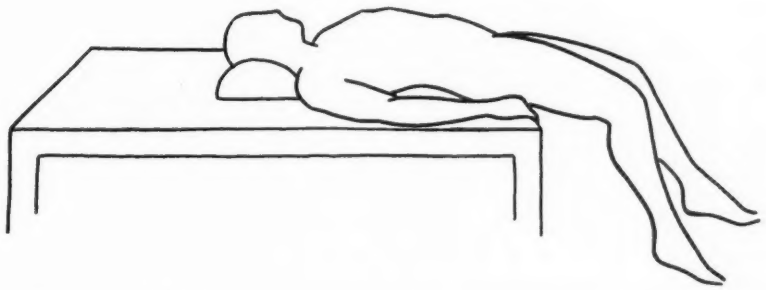


Fig. 8.—Recommended position for hyperextension test: extension of painful leg (left) restricted.

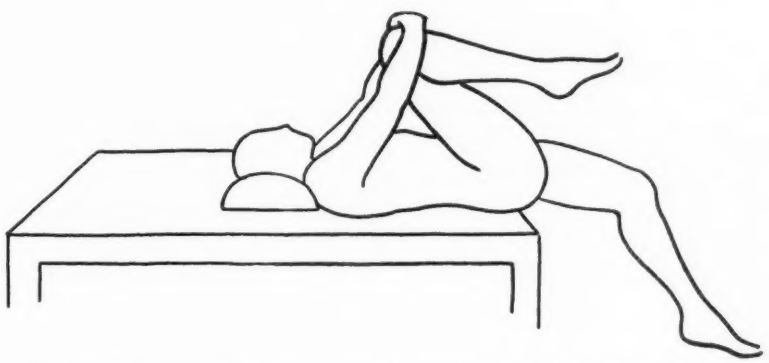


Fig. 9.—Hyperextension test: flexing normal thigh relieves painful leg.

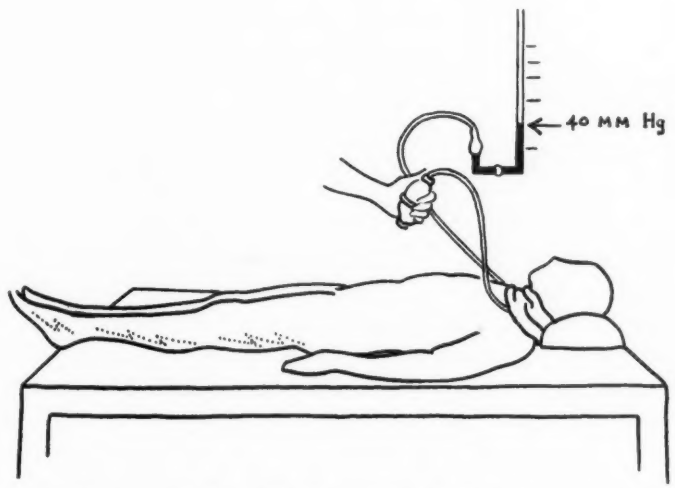


Fig. 10.—Recommended method for performing jugular compression test.

mon: (1) low back disability; and (2) pain in the distribution of the sciatic nerve.

The characteristic findings are as follows:

Fourth Lumbar Interspace:

1. Tenderness to percussion about the fourth spinous process.
2. Radiating pain on percussing to the side of the fourth spinous process.
3. Positive jugular compression test with tingling into the great toe (the fifth lumbar dermatome).
4. Knee and ankle jerks normal.
5. Hypesthesia and/or paresthesia in the fifth lumbar and the first sacral dermatomes.

Fifth Lumbar Interspace:

1. Tenderness to percussion about the fifth spinous process.
2. Radiating pain on percussing to the side of the fifth spinous process.
3. Positive jugular compression test with tingling into the top of the foot, sparing the great toe.
4. Diminished or absent ankle jerks; knee jerks normal.
5. Hypesthesia and/or paresthesia in the first sacral and the second sacral dermatomes.

DIFFERENTIAL DIAGNOSIS

If an injury initiates the symptoms of low back and sciatic pain, particularly if the injury has been a severe one, fracture of the spine or pelvis must be ruled out by appropriate x-ray study. If the symptoms develop insidiously, chronic conditions which affect the spine should be considered and ruled out. These include tuberculosis, low-grade osteomyelitis, Marie-Strümpell, rheumatoid and osteo-arthritis, myositis, fasciitis and congenital anomalies, especially spina bifida occulta and spondylolisthesis. Chronic or subacute abdominal conditions must be taken into consideration, although they rarely cause severe low back pain. Lesions in the prostate, particularly carcinomas, and metastatic tumors in the spine or pelvis from the breast, thyroid, lungs, prostate, kidney, and gastrointestinal tract must always be considered.

Differentiation between these lesions in the spine and pelvis is not, as a rule, difficult if the examination is carefully carried out in an orderly manner. However, in approaching the problem of low back disability, one frequently must exhaust his diagnostic acumen to arrive at a logical explanation for the pain, and not infrequently even the most careful study leaves the question unanswered. Appreciation of the fact that there is a definite clinical picture associated with rupture of the intervertebral disc and herniation of the nucleus pulposus will considerably reduce the number of cases formerly classified as low back pain of undetermined etiology.

MYELOGRAPHY

Abundant clinical experience has indicated that in 60 per cent of lumbar herniations of the nucleus pulposus, the diagnosis can be established accurately upon clinical findings alone. The remaining 40 per cent can be demonstrated only by exploratory operation or by satisfactory myelography. While an exploratory operation may be a justifiable procedure, particularly if the operator is skilled in this type of surgery, one would prefer to use a simple and more precise method.

Myelography has, for the most part, been performed by three methods: (1) lipiodol; (2) thorotrast; or (3) air (or gases).

Lipiodol is in many respects a satisfactory medium for visualizing the spinal subarachnoid space. However, if the material is not removed, its telltale shadow persists more or less indefinitely. It can be removed, but the removal is attended with difficulties and at best is often incomplete.

Thorotrast gives excellent radiographic detail and interpretations can be made with great accuracy. Thorotrast can be removed completely by continuous spinal drainage. However, there are many objections to its use, not the least of which is the time-consuming procedure of continuous spinal drainage.

Air myelography is used more universally than any of the three because air is absorbed and leaves no demonstrable x-ray evidence of its use. The headache following this examination is often severe and incapacitating. The shadows cast by gases in the spinal subarachnoid space are, with highly refined radiographic technique, subject to fairly accurate interpretations. However, in many instances the radiographic diagnosis is presumptive and often equivocal.

A new myelographic medium is now available which combines the desirable qualities of lipiodol and thorotrast, and is more easily removed by aspiration. If a few drops are left, they are gradually absorbed. The material is Pantopaque and is the contribution of Dr. Stafford L. Warren, Professor of Roentgenology, University of Rochester (N. Y.) School of Medicine, and Dr. William Strain of the Eastman Kodak Company.

The technique of pantopaque myelography used at the Walter Reed General Hospital is as follows:

The patient is placed prone on the tilting fluoroscopic table with a small pillow beneath the abdomen. Lumbar puncture is done in this position, the needle being inserted distal to the fourth or the fifth lumbar spinous process. The puncture may be done below the third spinous process but at this level subsequent removal of the pantopaque is more difficult. Spinal puncture in the face-down position is as simple when one is accustomed to it as in the conventional position. One must be careful to keep in the midline and to insert the needle millimeter by millimeter after the ligamentum flavum is encountered. As soon as

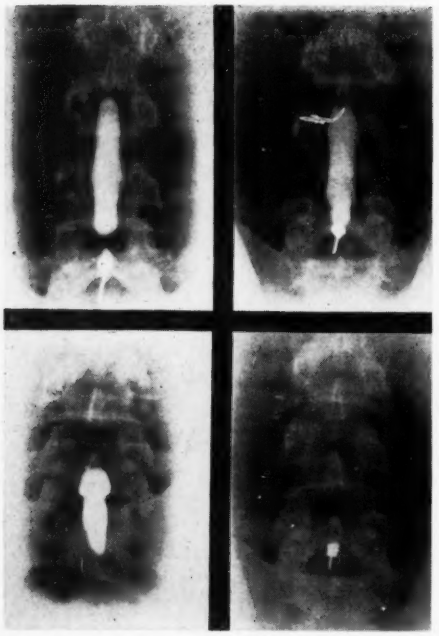


Fig. 11.—Normal Pantopaque myelogram. Spinal needle shown at fifth lumbar interspace in *A*, *B*, and *D*. At *C* the pantopaque shadow hides the shadow of the needle. Note the smooth column with normally filling axillary pouches at the third lumbar (*A*), fourth lumbar (*B*), and fifth lumbar (*C*) interspaces. At *D* the opaque material has been aspirated after the myelographic study has been completed.

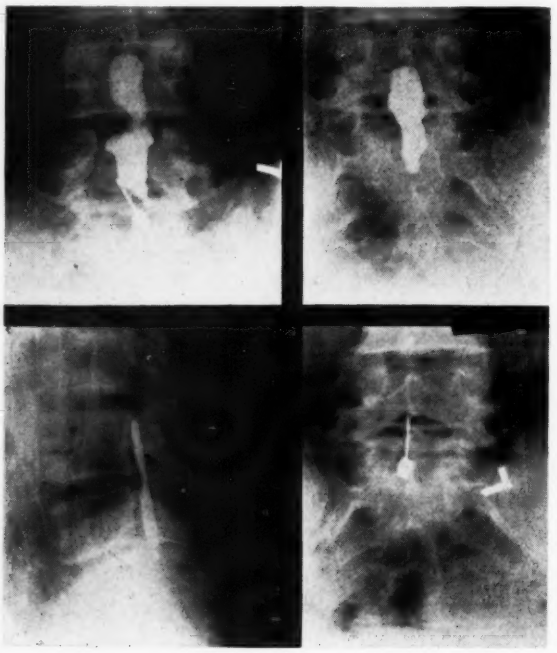


Fig. 12.—Pantopaque myelogram of a large herniated nucleus pulposus at the fourtn lumbar interspace. *A*, The large filling defect on the right; *B*, normal column and axillary pouches at the fifth lumbar interspace; *C*, lateral view showing characteristic anterior defect at the fourth lumbar interspace; *D*, complete removal of opaque material. Note the spinal needle at the fifth interspace in *A*, *C*, and *D*.

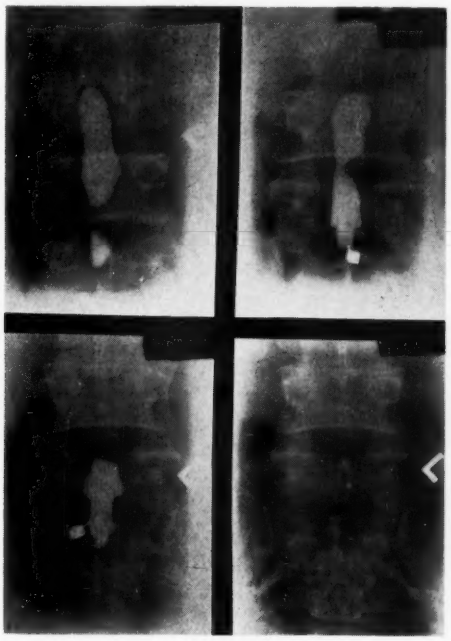


Fig. 13.—Pantopaque myelogram of a large herniated nucleus pulposus at the fourth lumbar interspace. *A* shows broken column at the fourth lumbar interspace; *B*, large left defect with dense column above and below the lesion connected by a thin isthmus of opaque material; *C*, normal myelogram at the fifth lumbar interspace; *D*, complete removal of the drug.

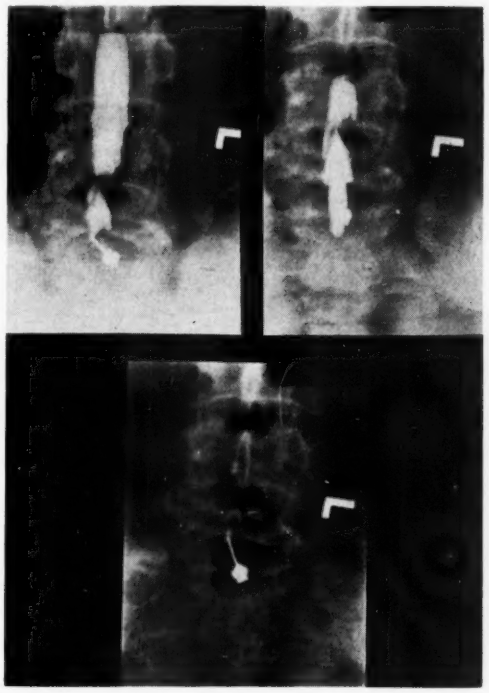


Fig. 14.—Pantopaque myelogram of a herniated nucleus pulposus at the fourth lumbar interspace on the left. *A*, Normal column and axillary pouches at the third lumbar interspace with defect beginning to form at the fourth lumbar interspace, spinal needle at the fifth lumbar interspace; *B*, characteristic defect at the fourth lumbar interspace left, with normal column at the fifth lumbar interspace; *C*, complete removal of drug.

spinal fluid is obtained, the needle is inserted further about 2 mm., and 3 c.c. of pantopaque are injected. A stylet is then placed in the needle and the whole field covered with a sterile towel. The patient is now ready for fluoroscopy.

Pantopaque, being of low viscosity, is easily balanced at the desired level in the spinal canal by tilting the fluoroscopic table. Pantopaque, being heavier than spinal fluid, always seeks a dependent position in the subarachnoid space. As the column passes each of the lower lumbar intervertebral discs, spot films are made. Where suspicious defects are

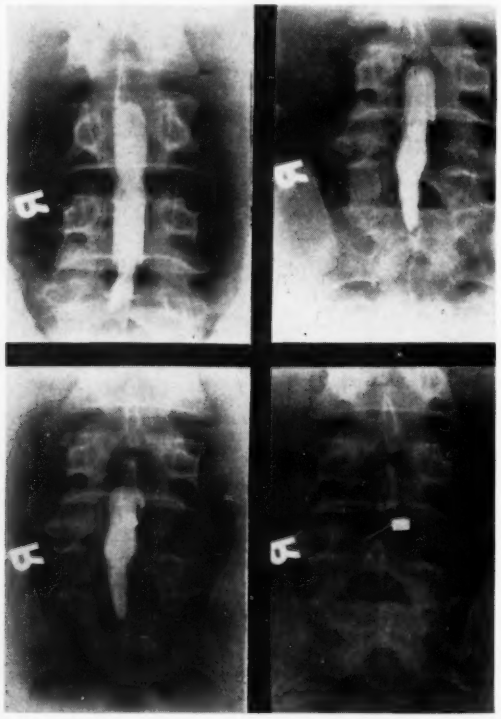


Fig. 15.—Pantopaque myelogram of herniated nucleus pulposus at the fifth lumbar interspace on the left. *A*, Normal myelogram at the third and fourth lumbar interspace; *B* and *C*, entire column shifted to right at the fifth lumbar interspace with very slight indentation below first sacral axillary pouch; *D*, complete removal of the drug.

encountered, oblique or lateral films (made with a portable unit) are helpful. Once the lesion is demonstrated and spot films of all suspected areas recorded, the column of pantopaque is balanced at the point of the needle by tilting the table to the desired position. The needle is introduced about 2 mm. further in order that aspiration may be accomplished as close to the anterior wall of the spinal canal as possible. A syringe is then attached and gentle aspiration begun. If the column has been carefully placed at the point of the needle, pure pantopaque will be obtained and almost the entire amount may be recovered before fluid begins to bubble through the oily mixture. When spinal fluid ap-

pears, the syringe should be detached, the stylet reinserted, and again the patient fluoroscoped to collect what remains of the pantopaque around the point of the needle.

The whole examination, when one is experienced, requires but fifteen to twenty minutes, including the injection and removal of the drug.

Spot films made with a stationary grid show remarkably accurate detail. The dural sleeves and the axillary pouches are outlined in most instances, and not infrequently the whole course of the nerve root may be shown at each level.

Myelography with pantopaque, like myelography with other media, should not be attempted soon after a diagnostic lumbar puncture, certainly not until at least a week or ten days have elapsed. The continuous fluid drainage through the needle hole in the arachnoid often produces sufficient subdural fluid to make another subarachnoid puncture difficult or impossible. This is the most frequent cause of subdural and extra-arachnoid injections and, of course, when it occurs the myelograms are useless for interpretation. It is better practice to remove spinal fluid for examination at the completion of the myelogram rather than to do a routine diagnostic puncture during the preliminary study.

Experience with some 200 pantopaque myelograms indicates that interpretations can be made with remarkable accuracy. No untoward reactions are to be expected if the drug is removed immediately following the examination.

SUMMARY

1. The importance of rupture of the lower lumbar intervertebral discs in the larger problem of low back disability is emphasized.

2. The characteristic history and physical findings are enumerated and discussed.

3. Accurate diagnosis and localization of the lesion on clinical findings alone are feasible.

4. The technique of myelography using a new medium is presented.

THE USE OF PHLEBOGRAPHY AND LUMBAR SYMPATHETIC BLOCK IN THE DIAGNOSIS OF VENOSPASM OF THE LOWER EXTREMITIES

A Preliminary Report

E. M. Papper, M.D.,* and Allison E. Imler, M.D.*
Palm Springs, Calif.

(From the X-ray Service and Anesthesiology Section of the Surgical Service, Torney General Hospital)

IN RECENT years, investigators have made increasing use of phlebography in the diagnosis and treatment of thrombophlebitis and pulmonary embolism resulting therefrom.[1-5] Despite the accumulation of considerable experience with this method, there are still many controversial problems connected with its use. One of these problems has been the correct interpretation of filling defects in veins. Conceivably, these abnormalities may be due to partial or complete occlusion of the veins by thrombi, spasm of the veins, or a combination of both.

The attempt to differentiate these conditions is of practical and theoretical importance. Although there is disagreement as to the indications for femoral vein ligation in thrombophlebitis, both Fine and his co-workers[5] and Ochsner[6] agree that for certain types of thrombophlebitis, that is, the presence of suppuration of the veins and phlebothrombosis, ligation is indicated.

Members of the former group are more radical in their approach, maintaining that ligation is indicated in all cases of thrombophlebitis. Whatever stand one takes, the usefulness of phlebography as an aid in the diagnosis of the presence of a thrombus as opposed to venospasm alone cannot be denied. Further, as will be shown, the diagnosis of venospasm and the demonstration of the innervation of the deep veins of the lower extremity is an important concept in the pathologic physiology of the venous system. Fine[5] points out, "A reliable differentiation between the two processes (venospasm and thrombosis) awaits the development of an effective and simple technic to relax venospasm during roentgenography, so that the diagnosis of thrombophlebitis will be possible on the basis of structural filling defects only."

The material presented in this report demonstrates an "effective and simple technic" to differentiate venospasm from thrombosis, namely lumbar sympathetic block.

METHODS

Technique of Phlebography.—All patients are interrogated concerning a history of allergic manifestations and also receive an oral sensitivity test for diodrast.

Received for publication, Sept. 24, 1943.

*Captain, Medical Corps, Army of the United States.

The routine phlebograms are made by the slow injection of 25 c.c. of 35 per cent diodrast into any suitable vein on the foot, with the patient in the supine position. An anteroposterior roentgenogram of the leg is taken after the injection of from 15 to 20 c.c. of the contrast media. The leg is held in internal rotation in order to project the tibial veins into the interosseous space and the exposure is made on a 14 by 17 cassette with its upper border just above the knee. The roentgenogram of the thigh is taken immediately after completion of the injection (one minute). A soft rubber tourniquet, tight enough to obstruct the superficial venous circulation, is allowed to remain in place during the entire procedure. This technique will permit satisfactory visualization of all the deep venous channels. The superficial circulation is outlined by injecting the diodrast into the distal portion of the internal saphenous vein and omitting the use of the tourniquet. Not infrequently, from a single injection of the contrast media, both the superficial and deep veins will contain adequate density of media for interpretation.

If abnormal findings are present on the routine studies, phlebography is repeated to rule out technical errors such as inadequate concentration of media, and serial films of the involved area are taken.

There were no abnormal reactions to the injection of diodrast.

Lumbar Sympathetic Block.—This procedure is performed by the standard paravertebral approach. Toward the anterolateral surface of the second, third, and fourth lumbar vertebrae, 8 to 10 cm. needles are inserted from a point 5 cm. lateral to the midline of the caudal end of the corresponding spinous process. Injection of 10 c.c. of 1½ per cent metycaine in normal saline solution is performed in each area after the needle tip has just lost contact with the anterolateral surface of the vertebral body. In the absence of a constant temperature room, sympathetic denervation was considered adequate when the blocked extremity became obviously warm, pink, and dry and when the superficial veins of the foot became prominent. These conditions were fulfilled in all instances and appeared within fifteen minutes of completion of the block.

In the cases to be described, lumbar sympathetic block was performed within twenty-four hours of phlebographic study and phlebograms were repeated within the first hour after block.

CASE 1.—C. S., aged 32 years, a white soldier, was admitted to Torney General Hospital with the diagnosis of chronic cellulitis of the right leg with skin atrophy. The illness began in 1936, seven years prior to admission, when he suffered severe lacerations of the mid-portion of the right leg in an automobile accident. No fractures were sustained. Since the injury he has had pain and tingling in the affected leg on exertion and has had several episodes of skin ulceration at the site of injury.

Phlebography revealed a uniform constriction of the popliteal vein (Fig. 1) and the diagnosis of venospasm was made. Lumbar sympathetic block was performed and serial phlebograms were obtained beginning one-half hour after com-

Fig. 2.—Phlebogram made one hour following lumbar sympathetic block shows a normal popliteal vein.

Fig. 1.—Uniform symmetrical narrowing of the right popliteal vein seen on original phlebographic studies.

Fig. 4.—Studies made following a second lumbar sympathetic block again show a disappearance of the constriction of the right popliteal vein.

Fig. 3.—Constriction of right popliteal vein present on phlebographic studies made one week after initial block.

pletion of the block. Although the skin exhibited the characteristic evidence of sympathetic denervation, the initial film revealed no change in the diameter of the vein. However, there was progressive increase in the lumen of the vein until the end of the first hour post block when the vein was entirely normal (Fig. 2). This patient had pain relief for about five hours.

One week later these studies were repeated. The spasm of the popliteal vein was noted again and was again abolished by lumbar sympathetic block (Figs. 3 and 4).

Fig. 5.—Original phlebographic studies of the left lower extremity were negative except for a uniform narrowing of the left external iliac vein.

CASE 2.—F. G., a white man, 33 years old, with two years and nine months military service, was admitted to Torney General Hospital complaining of difficulty in walking, swelling of both feet, pain in the calf muscles, especially the left, and dilatation of the veins of his legs, all of six months' duration. Past history revealed an inguinal herniorrhaphy of the left side, in 1940. Physical examination showed varicosities of the superficial veins of both extremities and an adequate deep circulation as judged by the Perthes test. The feet exhibited dependent cyanosis and blanching on elevation. The peripheral pulses in both feet were palpable. Laboratory studies including urine, blood, and spinal fluid were normal. On admission, thromboangiitis obliterans was suspected.

Phlebography revealed normal deep circulation bilaterally except for a moderate symmetrical constriction of the left external iliac vein (Fig. 5). The diagnosis of venospasm was made.

Lumbar sympathetic block was then performed on the left side followed by phlebography. There was a definite increase in the width of the external iliac vein (Fig. 6). It is interesting to note that this patient had excellent symptomatic relief for about eighteen hours.

Fig. 6.—Increase in width of the left external iliac vein following lumbar sympathetic block.

CASE 3.—H. W., a white soldier, aged 22 years, with three years military service, was admitted to Torney General Hospital with the diagnosis of chronic, recurrent, migratory phlebitis of the right great saphenous vein. The illness began with an injury to the right leg six months prior to admission to this hospital. Thrombophlebitis of the right great saphenous vein developed shortly after the injury. Ligation of the right great saphenous vein was performed at another hospital five months after the onset of the illness. Cure was not effected and the patient continued to suffer with recurrent saphenous thrombophlebitis and pain in the leg on exertion.

Six months following the original injury, and three days after admission to Torney General Hospital, phlebography revealed thrombosis of the deep femoral system with obstruction of the superficial femoral vein and thrombosis of the pro-

A.

B.

Fig. 7.—*A*, Original phlebographic studies of the right lower extremity showing obstruction of the superficial femoral vein and thrombosis of the profunda femoris. Note the filling defects in the profunda femoris. *B*, Normal popliteal and tibial veins as part of studies taken same time as *A*.

Fig. 9.—Increase in diameters of the popliteal and tibial veins but persistent filling defect on lateral wall of posterior tibial vein.

Fig. 8.—Uniform constriction of the right popliteal and anterior and posterior tibial veins (proximal portions) appearing five weeks after Fig. 7*A* and *B*.

funda femoris vein with partial recanalization (Fig. 7*A*). The popliteal and tibial veins were normal (Fig. 7*B*).

Phlebography was repeated five weeks after the first studies and demonstrated again, the defects noted. However, in addition, there was a uniform constriction of the distal end of the popliteal vein and the proximal portion of the anterior and posterior tibial veins, which was not present previously (Fig. 8). The diagnosis of venospasm was made, probably caused by the associated thrombophlebitis.

Lumbar sympathetic block was performed and phlebograms obtained. Following block, there was widening of the diameters of the distal end of the popliteal vein and the proximal ends of the anterior and posterior tibial veins, with a persistent filling defect on the lateral wall of the posterior tibial vein. The diagnosis of venospasm was substantiated and the concomitant presence of a thrombus in the posterior tibial vein was demonstrated (Fig. 9). This case demonstrates the co-existence of thrombosis and superimposed venospasm.

Clinically this patient had been improved. The weakness and pain in the leg disappeared following the single injection, and the patient remained free of symptoms for two weeks.

DISCUSSION

Examination of these cases and the radiographic demonstrations clarify some aspects of phlebography and the function of the deep veins of the extremities. However, there are new problems which remain to be answered. It will be noted that two cases of what is interpreted as venospasm and one case of thrombosis with superimposed venospasm are presented.

The first point that arises is the question of whether venospasm exists at all as a disease entity. Most comments on the problem of peripheral vascular tone discuss changes in the arterial or arteriolar tree alone either with no mention of venous tone or lumping the entire problem in the use of the word vasospasm. Perhaps the only specific mention of venospasm is made by Oehsner and DeBakey[7] who have postulated that many of the signs and symptoms of thrombophlebitis are due to spasm of the arterial and *venous* systems with impulses originating from the diseased area. They have demonstrated conclusively with the use of lumbar sympathetic block that this reflex can be interrupted and that the release of arteriolar spasm is of distinct benefit.

However, it is felt that objective evidence of the possibility of venospasm of the deep veins has been lacking up to the present time. It is of interest to note that our cases support the postulates of these workers in two respects; first, that there is an entity of venospasm, and second, that thrombophlebitis may set up a reflex venospasm about the diseased area as shown in Case 3.

In searching for anatomic or physiologic evidence for the innervation of the deep veins of the lower extremities, little can be found in previous work. Best and Taylor[8] point out that veins receive constrictor fiber from the sympathetics. However, this statement includes only superficial veins of the limbs and no mention is made of the deep venous circulation. Davis[9] also mentions the innervation of veins by the sympathetics, but again there is no specific statement regarding the deep

venous circulation. A point of interest is the opinion that these fibers are given off segmentally in similar fashion to somatic nerves.

It is our thesis, on the basis of this preliminary work, that the deep veins of the lower extremity are innervated by the lumbar sympathetic outflow and that it is possible, as demonstrated in these cases, for excessive tone of this outflow to exist, resulting in spasm of the deep veins. Denervation of the veins by lumbar sympathetic block effectively removes this excess venous tone and allows the veins to dilate. These opinions are substantiated by phlebographic evidence.

There is an important criticism which may be levied against this concept. It is conceivable that dilatation of the veins observed may not be due to relaxation of spasm, but to passive distention by increased blood flow from the dilated arteriolar tree. This objection may be answered by the following argument. There is the probability that the dilatation of arterioles as a result of sympathetic denervation is a skin phenomenon, rather than a generalized one in the entire extremity. Further, the superficial veins are visibly dilated. It would seem apparent, then, that the preferential return of blood would be superficial rather than via the deep circulation. This argument could be settled definitely by direct measurement of the femoral arterial pressure by optical manometry and the rate and volume of blood flow emerging from the extremity. Unfortunately, equipment was not available for these determinations. It is hoped that these measurements will be made in the future.

Another factor mitigating against arteriolar overflow distending the affected vein, especially in the popliteal area, is the rich venous anastomosis in this region which should absorb readily any increased supply of blood resulting from arteriolar dilatation. Finally, it should be pointed out that arteriolar dilatation is evident at least fifteen minutes previous to venous dilatation, and frequently longer. If arteriolar overflow were the explanation, one should find evidence of distention of the veins almost at once, and such is not the case.

One question remains unanswered completely. It is not known from this work whether sympathetic innervation to the deep veins of the lower extremity is segmental or diffuse. It can be said with certainty, however, that the innervation is in the lumbar sympathetic chain.

There are many details which still await further study. More experience must be acquired as to the correct time interval for phlebography after nerve block, and until more information can be obtained, it seems advisable to obtain serial roentgenograms. Also, more emphasis should be placed on this disease to make the clinician more aware of its presence. Possibly, until more is known, painful extremities of obscure etiology might profitably be subjected to phlebographic study as well as suspected cases of thrombophlebitis.

The problem of therapy is another interesting matter for consideration. Our experience is too meager to do more than indicate possibil-

ities. It would seem rational to perform repeated lumbar sympathetic blocks at daily intervals in the manner suggested by Ochsner and DeBakey[7] for the treatment of thrombophlebitis. Possibly in this manner, the reflex arc would be abolished. Certainly, in this small experience, all the patients received dramatic relief of symptoms for varying periods of time. Phlebography should be done at intervals in the course of treatment to note any permanent change in the status of the venospasm.

Finally, a plea is made for more accurate definition of terms. We believe the term vasospasm should be discarded in favor of more accurate terminology. If the disease is arteriolar, it should be designated arteriolarspasm, and if in the veins, as venospasm. Perhaps in this fashion more information will be obtained concerning the separate parts of the circulation.

SUMMARY

1. Three case reports of venospasm of the deep veins of the lower extremity are presented.

2. The presence of a uniform symmetrical narrowing of a vein in the roentgenogram with adequate concentration of media is believed to be diagnostic of venospasm. This diagnosis is confirmed if the deformity is completely abolished by lumbar sympathetic block.

3. The concomitant presence of thrombosis and venospasm may be suggested only by comparing phlebographic studies before and after lumbar sympathetic block.

4. Evidence for the innervation of the deep veins of the lower extremity by the lumbar sympathetic nervous system is presented.

5. Suggestions for therapy of this disease are made.

REFERENCES

1. Dos Santos, J. C.: Direct Venography; Conception, Technique, First Results, J. Internat. de chir. 3: 625, 1938.
2. Bauer, Gunnar: A Venographic Study of Thromboembolic Problems, Acta chir. Scandinav. (Supp. 61) 84: 1-75, 1940.
3. Dougherty, John, and Homans, John: Venography, A Clinical Study, Surg., Gynec. & Obst. 71: 697, 1940.
4. Welch, Claude E., Faxon, Henry H., and McGaley, Claude E.: The Application of Phlebography to the Therapy of Thrombosis and Embolism, SURG. 12: 163-183, 1942.
5. Fine, Jacob, Frank, Howard A., and Starr, Arnold: Recent Experiences With Thrombophlebitis of the Lower Extremity and Pulmonary Embolism. The Value of Venography as a Diagnostic Aid, Ann. Surg. 116: 574-97, 1942.
6. Ochsner, Alton: Discussion of, Fine et al.[5]
7. Ochsner, Alton, and DeBakey, Michael: Thrombophlebitis: The Role of Vasospasm in the Production of the Clinical Manifestations, J. A. M. A. 114: 123, 1940.
8. Best, C. H., and Taylor, N. B.: Physiological Basis of Medical Practice, Ed. 3, Baltimore, 1943, Williams & Wilkins Company, p. 149.
9. Davis, L.: The Principles of Neurological Surgery, Ed. 2, Philadelphia, 1942, Lea & Febiger, p. 396.

LESIONS OF THE BREAST

The Relationship of Benign Lesions to Carcinoma

O. T. Clagett, M.D.,* N. C. Plimpton, M.D.,† and G. T. Root, M.D.†
Rochester, Minn.

THE relationship of benign lesions of the breast to the subsequent development of mammary carcinoma is important and on its understanding rests the rational treatment of a potentially malignant condition. Although it is generally accepted that benign tumors seldom give rise to malignant ones, the question arises, is the incidence of carcinoma higher in the breast which has given rise to a benign tumor than in the normal breast. This question is exceedingly difficult to answer, but by a follow-up study, the incidence of mammary carcinoma among patients who have had a previously proved benign lesion of the breast can be ascertained with reasonable certainty. Such a study was carried out at this time in an endeavor to further our knowledge of this problem.

Excellent collective reviews of this subject have been presented recently by Campbell,[5] Patey,[15] Warren,[20] Davis,[9] and others and an extensive review of the literature will not be undertaken at this time.

Many men have given thought to the relationship between benign and malignant lesions of the breast. Sir Astley Cooper[8] was apparently the first to realize that all tumors of the breast were not malignant. In 1835, he mentioned some of the distinguishing clinical characteristics of these two types of lesions. Since that time, numerous men have made significant contributions in this field. Brodie,[4] in 1844, mentioned that he considered cysts of the breast to be benign but that their presence did not eliminate the possibility of a coexisting cancer. Reclus[16] observed that cysts and other benign conditions of the breast were frequently multiple and bilateral. The contributions of Billroth,[1] Brissaud,[3] Schimmelbusch,[17] Virchow,[19] and König[12] were concerned with the pathogenesis of benign lesions of the breast. They endeavored to ascertain whether their cystic nature was due to a process of retention or to an inflammatory, neoplastic, or involutional process.

Many of the earlier investigators have reported series of cases in which carcinoma was found in breasts on which operations were performed for a benign condition. Evidence of this type has been interpreted by some to mean that the malignant lesions arose from the associated benign lesion. Schimmelbusch, in reviewing the literature in 1892, reported carcinoma found in three of forty-three cases of benign

Received for publication, May 22, 1943.
*Division of Surgery, The Mayo Clinic.
†Fellow in Surgery, Mayo Foundation.

cystic disease, an incidence of 7 per cent. Several other men have reported series of 9 to 115 cases of benign lesions. The incidence of carcinoma found by these men varied from 7 to 36.3 per cent and such results were presumed to indicate the frequency with which a benign tumor turned malignant.

Other investigators have examined the parts of breasts, amputated for carcinoma, which were distant from the malignancy itself. Cystic disease was found in these specimens with varying frequency by the different workers. Semb[18] found that cystic disease was associated with carcinoma of the breast in 77 per cent of a series of 122 cases. He found similar changes in only one of thirty-two routine post-mortem cases. Charteris,[6] in a similar study, examined in detail forty-eight breasts removed for carcinoma and found chronic cystic mastitis to be present in all but seven. He found cystic changes in only five of thirty-two breasts obtained at necropsy. Fraser[10] noted similar epithelial changes but, because they were particularly marked in a centrifugal fashion around the malignant lesion, considered them to be secondary to the carcinoma rather than precursory. Lewis and Geschickter,[13] on the other hand, found cystic disease in only 1.1 per cent of a series of 2,675 cases of carcinoma of the breast.

Some workers have approached the problem from a still different angle. They have followed groups of patients who had previously undergone biopsy or removal of benign lesions from the breasts. In most of the studies made on this problem in recent years, this approach has been used. Interestingly enough, the results of these recent investigators have been much more consistent and have revealed a lower incidence of carcinoma than those of the workers who used either of the other two methods mentioned. From a statistical point of view, it is by far the most satisfactory method of approaching this problem. The incidence of carcinoma as reported by various workers varies from 0 to 4.8 per cent.

Warren, in an excellent follow-up study of 1,206 cases of benign disease of the breast, showed not only the incidence of carcinoma developing in this type of breast, but also compared this incidence with the attack rate of cancer of the breast in the general population. He showed that the cancer attack rate for the entire group of women having had chronic cystic mastitis or related lesions is four and one-half times as great as it is for the Massachusetts female population.

From the histologic approach have come reports that indicate a definite relationship between chronic cystic mastitis and carcinoma of the breast. The monograph of Cheatle and Cutler[7] is one of the outstanding contributions on this subject. They asserted that approximately 20 per cent of mammary carcinomas definitely began in cystiferous lesions. They also stated that the entire sequence of changes may be traced histologically from desquamative epithelial hyperplasia through

cyst formation, benign epithelial hyperplasia, to carcinoma. It is their belief that such a transition requires thirty years for its completion. Handley,[11] from a histologic approach, arrived at the conclusion that chronic mastitis is a precancerous condition and both mastitis and carcinoma have a common pathologic feature in lymphatic obstruction. Bloodgood,[2] on the other hand, stated that in 222 cases of chronic cystic mastitis in which simple mastectomy was performed, carcinoma could not be demonstrated in a single case.

CASES STUDIED AND RESULTS

In the present study, all the cases in which a benign condition of the breast was treated surgically at the Mayo Clinic during the years 1935 and 1936 were reviewed. The most common operative procedure used was local excision of the tumor. In some instances unilateral mastectomy and occasionally bilateral mastectomy had been done.

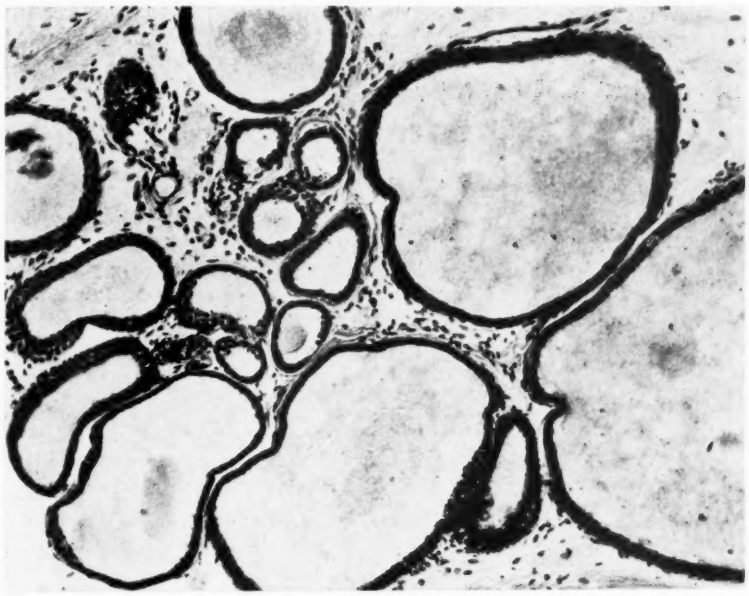


Fig. 1.—Chronic cystic mastitis, showing multiple cystic formations.

The entire group consisted of 540 patients. The pathologic nature of their lesions was classified into the following groups: chronic cystic mastitis; chronic mastitis; fibroadenoma; comedomastitis, and miscellaneous conditions. In the last group were included the lesions which did not present any marked pathologic abnormality.*

The majority of the patients in our series had chronic cystic mastitis (Fig. 1). This term is used to include all the cystic forms of mastitis

*We wish, at this time, to express our appreciation to Dr. J. R. McDonald of the Division of Surgical Pathology and Mr. Robert Gage of the Section on Biometrics for their helpful suggestions and criticisms.

(simple cysts, multiple cysts, and Schimmelbusch's hyperplasia). Grossly the breasts were nodular. Histologically, the nodules consisted of varying amounts of adenomatous tissue undergoing cystic formation. The group of cases classified as chronic mastitis (Fig. 2) referred to those lesions in which fibrous tissue or fat between the glandular tissue of the breast increased with a minimal amount of cyst formation.

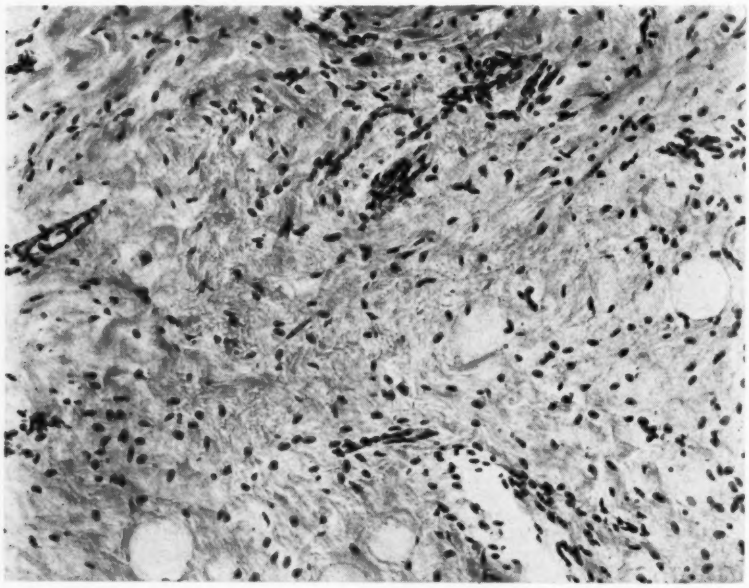


Fig. 2.—Chronic mastitis, revealing marked increase of fibrous tissue.

The term fibroadenoma (Fig. 3) was confined to those lesions in which a well-encapsulated tumor was removed and the glandular tissue was arranged in lobules; a varying amount of fibrous stroma was present. A small group of lesions was identified under the term comedomastitis (Fig. 4). A gross characteristic of these lesions was the debris which could be squeezed from the cut surface of the ducts when pressure was applied. Microscopically the ducts had thick fibrous walls and were filled with a relatively noncellular, homogeneous material. This type was associated, in some instances, with one of the other pathologic varieties.

The majority of the patients in the entire group were less than 50 years of age; approximately 25 per cent had passed the menopause.

The follow-up study was confined to 442 cases, thus eliminating sixty-eight cases in which bilateral simple mastectomy had been performed and thirty cases in which simple mastectomy had been done for a benign lesion, a radical mastectomy having been done previously on the opposite side for a malignant lesion. During 1942, question-

naires were sent to patients who had not been seen at the clinic within the past six months. Since all the patients had been operated on in 1935 and 1936, the follow-up period was five to six years. Three hundred eighty-two patients (86.4 per cent) were traced and it is from this group that the final results were derived (Table I).

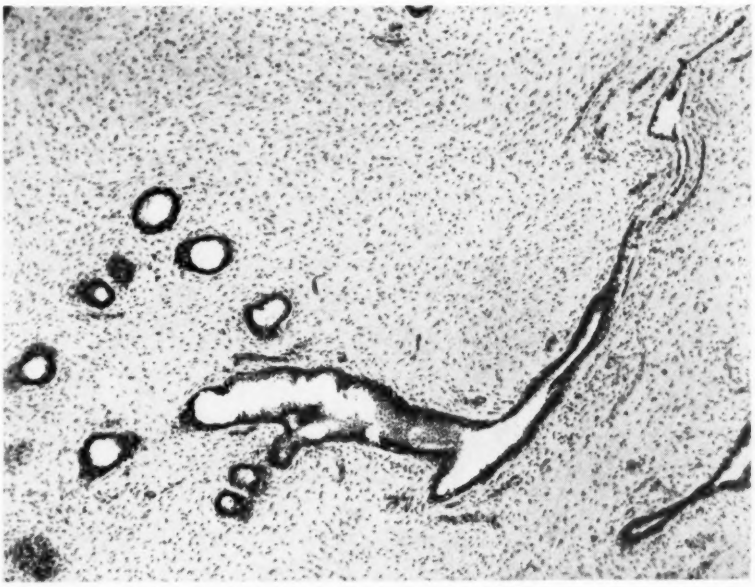


Fig. 3.—Fibroadenoma; an area showing both intracanalicular and pericanalicular types.

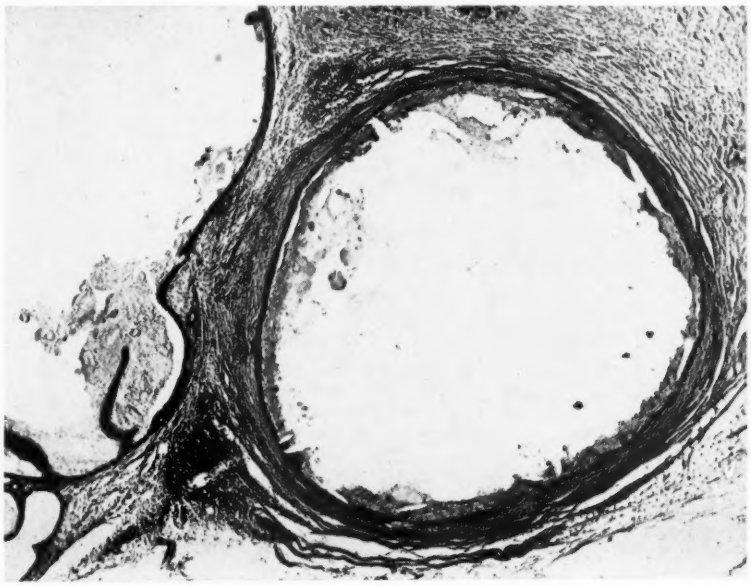


Fig. 4.—Comedomastitis; the thick walled ducts are filled with a noncellular homogeneous material.

TABLE I

FOLLOW-UP DATA IN 382 CASES OF BENIGN LESIONS OF THE BREAST

PATHOLOGIC TYPES	NUMBER OF PATHOLOGIC TYPES FOUND	CASES	CARCINOMA DEVELOPED	
			CASES	PER CENT
Chronic cystic mastitis	213	183	6	3.3
Fibroadenoma	124	109	0	0
Chronic mastitis	70	64	1	1.6
Comedomastitis	19	18	0	0
Miscellaneous conditions	8	8	0	0
Total	434	382	7	1.8

In seven (1.8 per cent) of the entire number of cases traced, carcinoma of the breast developed subsequently. None of these malignant lesions developed in a breast which had previously given rise to more than one type of benign lesion. Carcinoma was not found to occur in any of the cases of fibroadenoma or comedomastitis. However, carcinoma did develop among patients who previously had had chronic cystic mastitis (3.3 per cent) or chronic mastitis (1.6 per cent).

Two (28.6 per cent) of the seven patients who subsequently had carcinoma of the breast were past the menopause when they were first seen at the clinic. However, about 25 per cent of the entire group of patients had passed the menopause when they were originally seen, so that no definite conclusions may be drawn from this series of cases in regard to the effect of endocrine imbalance on the development of carcinoma of the breast.

COMMENT

We are well aware of the fact that such a study as this will not result in a final answer. We would like to be able to read the future and state exactly how many more patients will have carcinoma as they become older and reach the ages at which carcinoma of the breast is more likely to occur. However, the one finding that results from this five- to six-year follow-up study, which we may state as factual, is that 7 (1.8 per cent) out of 382 patients who previously had had a proved benign lesion of the breast, subsequently had carcinoma. This results in a yearly attack rate of about 0.30 per cent for this group.

The death rate for carcinoma of the breast in the state of Minnesota in 1940 was twenty-nine per 100,000 for women of all ages or thirty-one per 100,000 for women in the ages from 25 to 65 years.[14] It is the latter figure with which we are concerned in this study for it more closely resembles the ages of the patients in this series, and the mortality rate of this group from cancer of the breast was 0.031 per cent in Minnesota in 1940. Warren[20] stated, and we believe rightly so, that multiplying the mortality rate by two gives a fairly accurate figure for the morbidity or attack rate of carcinoma of the breast. This results in a yearly attack rate in the general population of 0.062 per cent and an attack rate in our series of patients with previously proved benign

disease of the breast, of 0.30 per cent. In other words, the incidence of cancer of the breast in this series was five times as great as was the incidence of cancer of the breast in the general population of women from 25 to 65 years of age in 1940 in Minnesota.

SUMMARY AND CONCLUSIONS

An attempt was made to trace 442 patients five to six years after surgical treatment at the clinic for benign lesions of the breast; 86.4 per cent of these patients were traced.

Carcinoma of the breast subsequently developed in seven cases, a crude attack rate of 1.8 per cent in the five- to six-year period.

Carcinoma was not reported in any case of fibroadenoma or comedomastitis, but it did develop in the groups of patients who had had chronic cystic mastitis (3.3 per cent) and chronic mastitis (1.6 per cent).

The incidence of carcinoma of the breast in the entire series was five times as great as was the incidence of carcinoma of the breast in the population of women from 25 to 65 years of age in Minnesota for the year 1940. Such findings emphasize the importance of following closely patients with cystic disease of the breast in order to observe any recurrence of a benign condition or a possible development of a malignant process.

REFERENCES

1. Billroth, T.: Quoted by Campbell, O. J.[5]
2. Bloodgood, J. C.: Quoted by Patey, D. H.[15]
3. Brissaud, M.: Quoted by Campbell, O. J.[5]
4. Brodie, B. C.: Quoted by Lewis, D., and Geschickter, C. F.[13]
5. Campbell, O. J.: Relationship Between Cystic Disease of the Breast and Carcinoma, Arch. Surg. **28**: 1001-1056, 1934.
6. Charteris, A. A.: Quoted by Patey, D. H.[15]
7. Cheatle, G. L., and Cutler, M.: Tumors of the Breasts; Their Pathology, Symptoms, Diagnosis and Treatment, Philadelphia, 1930, J. B. Lippincott Company, 596 pp.
8. Cooper, A. P.: Quoted by Lewis, D., and Geschickter, C. F.[13]
9. Davis, H. H.: Cystic Disease of the Breast, SURGERY **10**: 663-674, 1941.
10. Fraser, J.: Quoted by Patey, D. H.[15]
11. Handley, W. S.: Quoted by Patey, D. H.[15]
12. König, F.: Quoted by Davis, H. H.[9]
13. Lewis, D., and Geschickter, C. F.: Relation of Chronic Cystic Mastitis to Carcinoma of the Breast, Surg., Gynec. & Obst. **66**: 300-307, 1938.
14. Minnesota Department of Health: Cancer Deaths in Minnesota, March 31, 1942.
15. Patey, D. H.: Chronic Cystic Mastitis and Carcinoma; Collective Review, Surg., Gynec. & Obst. **68**: 575-579, 1939.
16. Reclus, P.: Quoted by Campbell, O. J.[5]
17. Schimmelbusch, C.: Quoted by Campbell, O. J.[5]
18. Semb, C.: Quoted by Patey, D. H.[15]
19. Virchow: Quoted by Davis, H. H.[9]
20. Warren, Shields: The Relation of "Chronic Mastitis" to Carcinoma of the Breast, Surg., Gynec. & Obst. **71**: 257-273, 1940.

STUDIES ON TRAUMATIC SHOCK

II. The Restoration of Blood Volume in Traumatic Shock*

Everett Idris Evans, M.D., Ph.D., G. Watson James, III, M.D., and M. J. Hoover, M.D., Richmond, Va.

(From the Department of Surgery, Medical College of Virginia)

STUDIES on the restoration of blood volume after traumatic shock are of practical importance because many patients in shock as a result of trauma usually need fairly active treatment for some hours or days after the initial shock has been successfully treated. This treatment may require a surgical operation, considerable change of position due to the need for further x-ray studies, subsequent blood transfusions because of redevelopment of shock, and means for combating a serious infection; the problems mentioned are only a few that might possibly arise.

There is at present a paucity of reliable observations on the rapidity with which blood volume is restored after a patient has recovered from the initial symptoms of traumatic shock. Unfortunately for the shock patient, too many persons place false reliance on the fact that in hemorrhage resulting in a small external loss of blood there is an almost immediate readjustment of blood volume by the drawing in from the extravascular spaces of protein-poor fluid, and consider that the same protective mechanisms operate readily and efficiently in traumatic shock.

We can discover only a few reliable observations that bear on this discussion as far as the human shock subject is concerned. Keith,[1] as pointed out in the earlier report,[2] determined for the first time the circulating blood volume in wounded soldiers in shock from serious wounds. At regular intervals after recovery from shock the blood volume was redetermined on several of these wounded individuals. Keith's observations and conclusions have been criticized strongly (and we believe probably unwisely) on technical grounds because he employed the vital red method for the estimation of plasma volume; it is now well known that with repeated determinations of blood volume by the vital red method, serious errors may be involved in the calculation of blood volume. However, Keith observed that although recovery from wound shock was associated with an increase in blood volume, this increase might in certain individuals be very slow, the normal blood volume level being attained only after three to five days.

Ebert, Stead, and Gibson[3] studied the rate of blood volume restoration in normal subjects from whom moderate amounts of blood had been

Received for publication, Nov. 3, 1943.

*This study was carried out under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and The Medical College of Virginia. It was initiated by a grant from The Committee on Scientific Research of the American Medical Association.

rapidly withdrawn. Circulatory collapse of short duration was produced but not of a degree severe enough to be termed hemorrhagic shock. In these individuals no attempt was made to restore blood volume by blood or plasma infusions. An analysis of their protocols shows that in four of the six subjects studied, the plasma volume had approached normal levels in eight hours (all in twenty-four hours); there was, however, some delay in the restoration of total circulating protein. Later studies by Ebert and associates[4] indicated that when this same procedure was carried out on dogs, but the animals kept in a state of hemorrhagic shock for twelve hours by the steady withdrawal of sufficient blood (after the initial bleeding) to maintain the blood pressure at shock levels, plasma volume restoration and protein replacement were decidedly slow.

We became interested in this matter of blood volume restoration in traumatic shock patients after observing in several cases the death of such patients on the second or third day (after trauma had been received), when the only thing done to the patient was to change radically his position in bed. One patient, for example, after having recovered from the initial severe shock after treatment with one blood transfusion, on the third day had a normal blood pressure, slightly elevated pulse rate, and no typical signs of shock. He was raised in bed to a better position for chest examination, when he suddenly expired. Another shock patient, similarly treated for severe traumatic shock, expired shortly after he had been moved on his side for a spinal tap on the third day after admission.

We were under the impression that the cause of death in these patients was probably a poor adjustment in the circulatory flow to the vital centers with a sudden change in body position, and being unaware of Keith's observations on the restoration of blood volume in shock with recovery, we carried out the present study.

METHOD

In the preceding article,[2] we outlined the plan of study for the estimation of blood volume of patients in shock as a result of severe trauma. From this larger group of patients in severe shock, there were selected eighteen patients (mostly with compound fractures of femur, or tibia and fibula). To each of these patients was given initially, after a plasma volume estimation was completed, enough blood or plasma to bring them out of shock, and restore blood pressure readings to normal levels. From that time on, no more blood or plasma was given for five to six days. They were placed on a liquid diet the day after admission, a soft diet on the third and fourth day, and if possible on a general diet on the fifth day after admission. No intravenous therapy was given; water by mouth was not withheld. A blood volume estimation was carried out at twenty-four-hour intervals, under basal conditions, until the plasma volume had returned to normal levels.

Any plasma protein accompanying the observed increase in plasma volume taking place after the initial shock had been treated must be considered, therefore, to have come from the protein storage depots or regenerated from ingested protein. The former is almost surely the case, because the protein intake on the diets used in the study period is admittedly quite low.

Plasma volume estimations were made by the Gregersen-Gibson dye method[5] as adapted to the Klett photocolorimeter. The hematocrit was determined by centrifuging blood specimens at 2,500 revolutions per minute in the Sanford-Magath 6 c.c. tube. The total cell volume was calculated from the plasma volume and the hematocrit reading; the plasma protein was determined by the falling drop method of Kagan.[6] The total circulating protein, in grams, was obtained by multiplying the plasma protein concentration in grams per 100 c.c., by the plasma volume, in hundreds of cubic centimeters. All samples of blood were taken without stasis.

Of the eighteen shock patients studied in this manner, six patients were selected for this report. The results obtained are representative of the group as a whole.

CASE REPORTS

CASE 1 (M. H.).—*Diagnosis:* Avulsion of scalp; blood loss; abrasion of abdomen, arms, and legs.

The patient was a 28-year-old woman who had been thrown down a hillside when a car overturned. On entry to the hospital she was screaming with pain and was irrational. Blood pressure was 90/50; pulse, 100 (poor quality); plasma volume, 25 c.c. per kilogram. She was brought out of shock with only 1,000 c.c. saline and thereafter was given only intravenous glucose. She recovered full consciousness slowly. Recovery was complete with no infection of scalp or abrasions. Abrasions were treated by sulfanilamide gauze-pressure dressings.

CASE 2 (H. L.).—*Diagnosis:* Traumatic amputation of left leg; severe secondary shock.

The patient was a 27-year-old man whose left leg had been run over by a train shortly before admission. He had been treated at the scene of accident by a physician who placed a tourniquet above the traumatized area of the leg. Examination showed profuse sweating of forehead and extremities. Pulse was 100, with fair volume and good venous filling. Extremities were cold; blood pressure, 130/50, falling soon after admission to 70/50, when pulse became rapid and thready. Plasma volume was 28.9 c.c. per kilogram. The injured leg was amputated above the knee under pentothal anesthesia, following which the patient was given 500 c.c. whole blood, his blood pressure rising to 100/60. Thereafter no more blood or plasma was given for four days; full recovery.

CASE 3 (J. W.).—*Diagnosis:* Compound fracture of right tibia, fibula; fracture of pelvis; fracture of neck of right femur.

The patient was a 68-year-old man who had been struck by a car fifteen miles from Richmond. The leg was splinted properly, the patient given morphine and

brought to the hospital by private car. On entry, the pulse was 110, fair volume; no sweating, but venous filling only fair. Blood pressure was 125/60 on entry, but fell in thirty minutes to 70/50. Given 250 c.c. of 5 per cent glucose, pressure rose to 128/70. Plasma volume on admission was 25 c.c. per kilogram. Given 500 c.c. of whole blood, the patient's blood pressure rose to 140/90. Under ether anesthesia, the compound fracture was reduced and a cast applied. Blood pressure fell to 100/60, so 250 c.c. of plasma were given, with a rise of blood pressure, thereafter maintained, to 120/70. After operation 500 c.c. of whole blood were given; thereafter no blood or plasma. Recovery was complete.

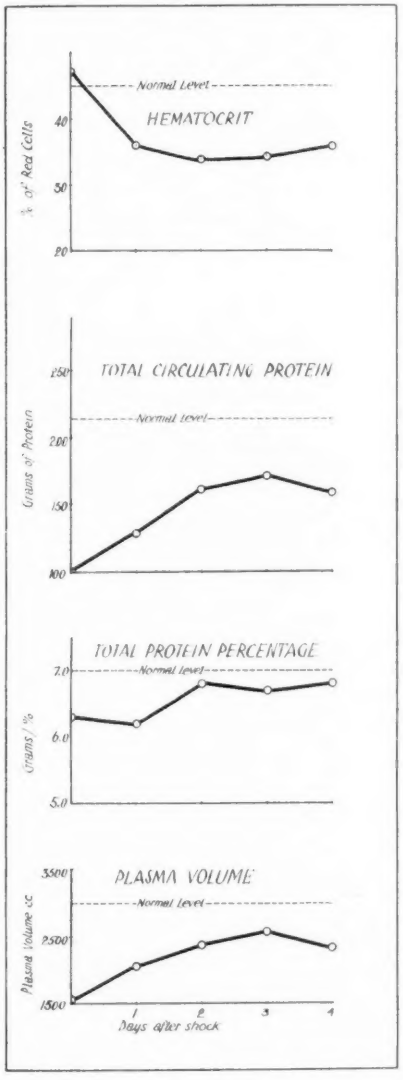


Fig. 1.

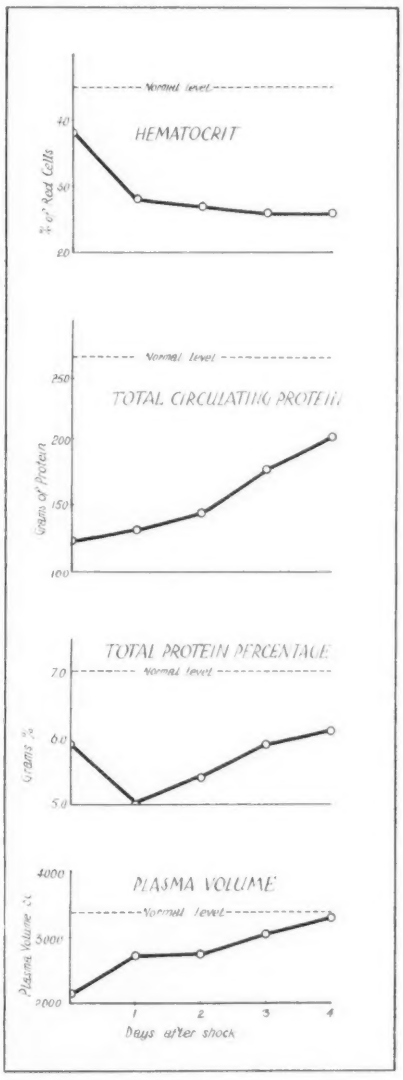


Fig. 2.

Fig. 1.—Case M. H. Restoration of blood volume in patient who had suffered severe body trauma. Plasma volume and total circulating protein showed marked deficit on the fourth day.

Fig. 2.—Case H. L. Restoration of blood volume in patient who had received severe trauma to lower limb, requiring amputation. Plasma volume and total circulating protein assumed practically normal levels by the fourth day, but hematocrit remained low.

CASE 4 (R. H. M.).—*Diagnosis:* Comminuted fracture of right femur.

The patient was a 20-year-old man who suffered fracture of the right femur in an automobile accident fifty miles from Richmond. He was brought by private car to the hospital without any attempt at splinting of the leg. At the time of entry he showed marked pallor, mucous membranes, and slight cyanosis. Venous filling was only fair and extremities were cool with no sweating. Pulse rate was 106; blood pressure, 90/60; plasma volume, 25.2 c.c. per kilogram. The leg was placed in a Thomas splint; 1000 c.c. of 5 per cent glucose brought the pressure to 126/80; thereafter, given 500 c.c. of whole blood, his pressure rose to, and stayed there-

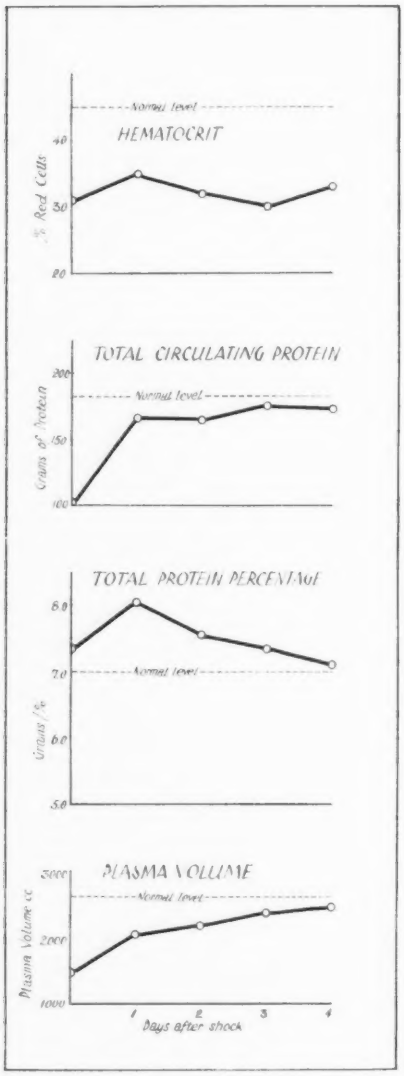


Fig. 3.

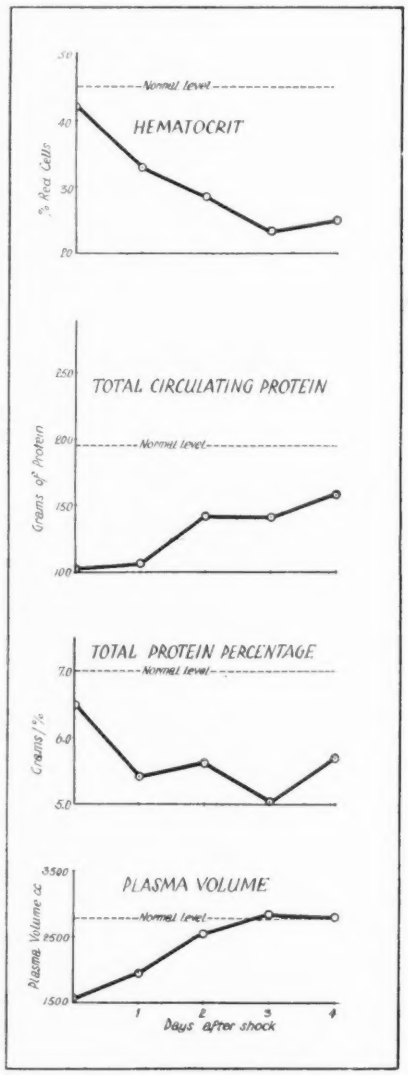


Fig. 4.

Fig. 3.—Case J. W. Restoration of blood volume in patient who suffered severe fractures of lower limbs and pelvis; slow restoration of plasma volume and total circulating protein. Hematocrit remained low despite 1,000 c.c. of whole blood in treatment of shock.

Fig. 4.—Case R. H. M. Comminuted fracture of femur. Total circulating protein not restored to normal level by fourth day and severe anemia persisted.

after at, 130/80. Plaster cast was put on and reduction done the next day. There was full recovery.

CASE 5 (T. W.).—*Diagnosis:* Fracture of pelvis; secondary shock.

The patient, a 23-year-old woman, was injured in an auto collision with a truck. She was brought to the hospital in a private car. On arrival she presented a picture of severe shock; pulse, 136, weak and of poor volume; upper extremities cold and clammy, lower extremities cold. Blood pressure was 70/50; plasma volume 33 c.c. per kilogram; 750 c.c. of saline were given with no response. When 25 Gm. of human albumen were given, pulse volume was greatly improved, rate dropped

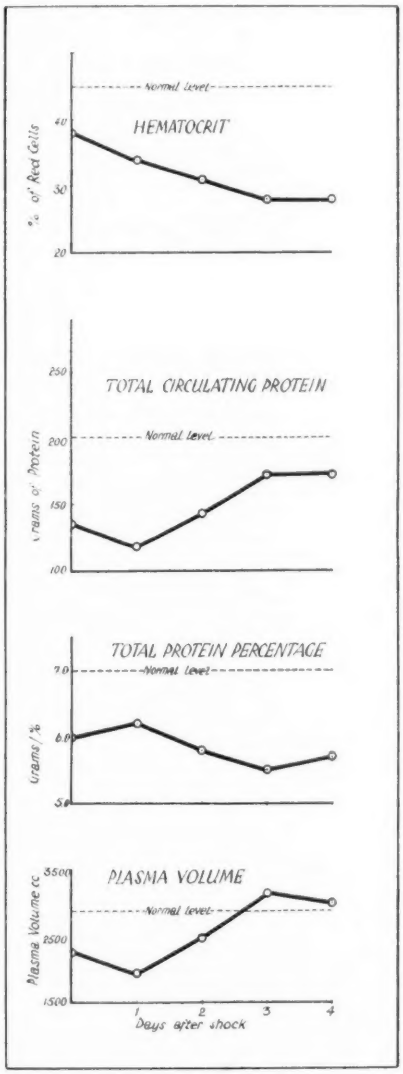


Fig. 5.

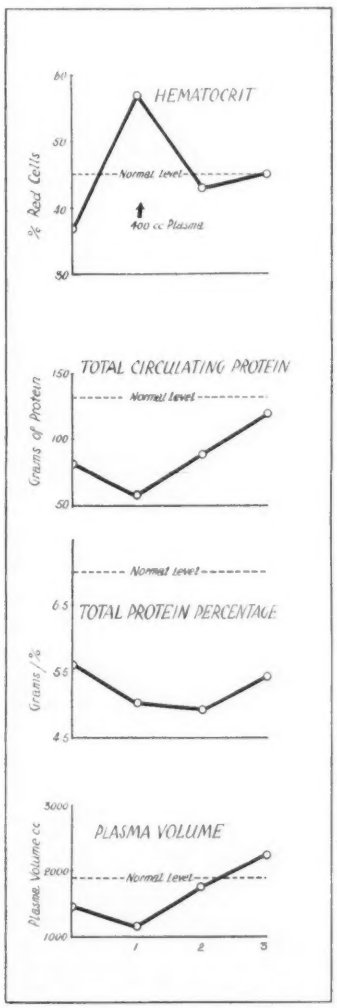


Fig. 6.

Fig. 5.—Case T. W. Fracture of pelvis. Total circulating protein was not restored by the fourth day and hematocrit remained very low.

Fig. 6.—Case M. J. Stab wound of abdomen. Patient received large amounts of whole blood. Hematocrit and plasma volume returned to normal levels on the second day, indicating the benefits of whole blood transfusions.

to 104, blood pressure rose to 88/50, and later to 100/70. Thereafter there was no further blood or plasma therapy. Full recovery took place.

CASE 6 (M. J.).—*Diagnosis:* Stab wound of abdomen; perforation of stomach; severed mesenteric artery.

The patient was an 18-year-old girl who was brought to hospital soon after receiving a stab wound of the abdomen. On examination, there were signs of severe shock. Blood pressure was unobtainable, limbs were cold and wet, and there was marked restlessness. Pulse rate was 140 (precordial); plasma volume, 30 c.c. per kilogram. Glucose, 100 c.c. of 5 per cent, and 500 c.c. of whole blood brought the blood pressure to 50/0, the pulse down to 124. Whole blood, 500 c.c., was started and the patient was taken to the operating room where celiotomy was carried out under intercostal block-pentothal anesthesia. When the abdomen was opened, considerable blood was encountered. The patient continued in severe shock until a severed mesenteric artery, freely bleeding, was ligated. During operation and in the ensuing nine hours the patient was given a total of approximately 2,500 c.c. of whole blood, with blood pressure finally rising to 120/80. Thereafter, because of high hematocrit (57 per cent) the following day, 400 c.c. of plasma were given. Recovery was complete.

RESULTS

A. *Quantitative Aspects of Blood or Plasma Replacement in Relief of Traumatic Shock.*—It is currently rather widely held that the amount of blood or plasma required to bring a patient out of shock indicates accurately the extent of blood or plasma loss in the patient. This impression has led some to discredit the "blood loss" theory of shock. They hold that if traumatic shock is due to blood or plasma loss, then there should be a good correlation between severity of shock and the amount of blood or plasma necessary to restore the blood pressure to normal levels. Although within certain well-defined limits this may be true, analysis by us of an abundant mass of blood volume data on shock patients shows without any doubt that a patient may be in severe shock from trauma (compound or simple fractures of femur, tibia, or pelvis), have a greatly reduced circulating blood volume, yet show a return of blood pressure to normal levels (and disappearance of other shock signs) with only enough blood or plasma to raise the plasma volume 2 to 3 c.c. per kilogram. A study of the case reports illustrates this fact. Although some of these shock patients had lost so much blood that the plasma volume was in the neighborhood of 25 c.c. per kilogram (normal being 45 c.c. per kilogram), only 250 c.c. of plasma or 500 c.c. of whole blood brought about a significant rise in blood pressure and recovery from shock.

Our experience in treating many shock patients supports these contentions: first, the severity of shock correlates well with the extent of blood loss as determined by blood volume estimation (dye technique); although this is true, the amount of blood or plasma necessary for full immediate recovery from shock may be no indicator of the severity of blood loss in a given instance.

Hence, we view with suspicion any claims that in a given case of severe shock the cause of shock must be other than a seriously reduced circulating blood volume because the patient's blood pressure was restored immediately and promptly by only a small transfusion of one pint of blood or plasma. Such claims become valid only when supported by blood volume data.

B. *Changes in Plasma Volume Following Traumatic Shock.*—It is becoming clearly apparent that reduction in circulating blood volume is a significant factor in the causation of traumatic shock (Keith; Blalock; Phemister; Gregersen; Evans), so we can expect to find a lowered plasma volume if the estimation is made soon after the trauma has been received. Examination of the plasma volume data of the six patients reported here (Table I, and Figs. 1 to 6) indicates that following the initial treatment for shock, the plasma volume increases only gradually for three to four days; usually a level approximating normal is reached only after seventy-two hours or more. In no patient was there a sudden large increase in plasma volume following shock.

C. *Relation of Plasma Volume Changes to Plasma Protein Concentration.*—Reference to Table I, Figs. 1 to 6, shows that there is no true relation of plasma volume changes to changes in plasma protein concentration, although in some patients not mentioned in detail in this report there seemed to be a tendency toward slight increase in plasma volume by the drawing into the blood stream of fluid poor in protein, especially in the first twenty-four hours after shock. It is clear, however, that there seems to be a definite relation between total circulating protein available and a change in plasma volume. It appears that there is a definite tendency to maintain normal osmotic pressure relationships in the restoration of plasma volume, plasma volume not increasing unless there is an increase in total circulating protein.

D. *Changes in Hematocrit Reading and Red Cell Volume.*—Each time a plasma volume determination was made it was possible to get accurate information on the hematocrit levels in at least five hematocrit tubes. Although the calculation of total red cell volume from hematocrit and plasma volume data may be open to some error, for clinical purposes the information gained may be valuable. From Table I, Figs. 1 to 6 it can be seen that in every shock patient (except M. J., who received massive whole blood transfusions) there was a serious fall in the hematocrit level, with no tendency toward return to normal values by the fourth day. Also, calculations of total red cell volume (Table I) indicate that on the fourth day the red cell mass is about the same as existed when the first blood volume determination was made, unless large amounts of whole blood were employed in the initial treatment of shock (see Table I, patients J. W. and M. J.).

Although the decrease in hematocrit readings at twenty-four hours after shock usually paralleled the increase in plasma volume, after that

TABLE I

DATE	HEMATOCRIT READING	TOTAL PROTEIN (GM. %)	PLASMA VOLUME (C.C.)	RED CELL VOLUME (C.C.)	TOTAL CIRCULATING PROTEIN (GM.)	COMMENTS
M. H. (Case 1)						
6/20/43	47	6.3	1564	1378	98.7	Given only 1,000 c.c. saline
6/21/43	36	6.2	2062	1162	128.0	
6/22/43	34	6.8	2378	1250	161.8	
6/23/43	34.5	6.7	2565	1351	172.0	
6/25/43	36	6.8	2340	1318	159.0	
H. L. (Case 2)						
5/20/42	38	5.9	2169	1330	127.9	Given 500 c.c. whole blood
5/21/42	28	5.0	2721	1060	136.1	
5/22/42	27	5.4	2751	1017	148.5	
5/23/42	26	5.9	3080	1082	181.7	
J. W. (Case 3)						
9/20/43	31	7.3	1490	670	104.2	Given 1,000 c.c. blood, 250 c.c. plasma
9/21/43	35	8.0	2033	1092	166.0	
9/22/43	32	7.5	2192	1030	165.0	
9/23/43	30	7.3	2389	1024	175.5	
9/24/43	33	7.1	2450	1208	174.0	
R. H. M. (Case 4)						
9/ 4/42	42	6.1	1565	1132	95.0	Given 500 c.c. whole blood
9/ 5/42	33	5.4	1954	965	106.0	
9/ 6/42	28.5	5.6	2530	1008	142.5	
9/ 7/42	23.5	5.0	2831	869	142.0	
9/ 8/42	25	5.7	2800	934	159.0	
T. W. (Case 5)						
7/20/43	38	6.0	2250	1380	135.0	Given 25 Gm. human albumen
7/21/43	34	6.2	1911	985	118.5	
7/22/43	31	5.8	2476	1112	143.5	
7/23/43	28	5.5	3149	1225	173.5	
7/24/43	28	5.8	3000	1169	174.0	
M. J. (Case 6)						
9/30/42	37	5.6	1446	734	81.0	Given 2,500 c.c. whole blood
10/ 1/42	57	5.0	1157	875	58.3	Given 400 c.c. plasma
10/ 2/42	43	4.9	1764	1330	87.0	
10/ 3/42	45	5.4	2207	1810	119.5	

time these readings appear not to be a useful guide in estimating the rate at which plasma volume may be increasing. (This lack of correlation between hematocrit readings and plasma volume estimation we have found also in unpublished studies on severely burned patients.)

COMMENT

These experiments show that after a patient has suffered trauma accompanied by blood or plasma loss severe enough to reduce the blood volume from 25 to 40 per cent, there is only a gradual, slow restoration of plasma volume. Even after three or four days, the plasma volume

may not have returned to a normal level. Although plasma volume estimation is undoubtedly more exact with the T-1824 dye technique, there seems now no doubt that Keith's studies gave fairly accurate information on this point in 1918.

A comparison between the rate of plasma volume restoration in these studies and those reported by Ebert, Stead, and Gibson[3] indicate that in the human subject plasma volume restoration is much slower after traumatic shock than after simple hemorrhage without shock. This was to be expected from the experiments on the dog in shock by Ebert and co-workers,[4] which indicated that mechanisms responsible for the elaboration or liberation of protein are probably impaired if the shock state exists for a moderately long period of time.

From a practical point of view, regarding the subsequent treatment of a person who has recovered from the immediate effects of severe traumatic shock, certain deductions are pertinent. It is obvious that the determining factor in the restoration of plasma volume in the shock patient is early and adequate quantitative replacement of circulating plasma protein. From the studies herein reported (and those of Ebert, Stead, Warren and Watts[4]), it is likely that large amounts of protein are not added to the blood stream early after hemorrhage or shock simply because protein depots with *readily available plasma protein* do not exist. Protein for the circulation must first be elaborated from protein stores or from protein that has been made available for this use by oral or intravenous administration of the building materials. For these reasons it is imperative that the treatment of the shock patient (regarding protein therapy) not end with bringing the patient out of shock, but be continued in the form of (1) enough plasma to restore plasma volume to normal levels (in the ordinary shock patient this would require from 1,000 to 1,500 c.c. of plasma) or (2) enough amino acids so that from 100 to 200 Gm. of protein can be elaborated (see Elman and associates[7]), or (3) a diet high in protein. In these first few days after shock has been sustained, the caloric intake of the patient must be kept high by carbohydrate therapy, so the plasma, amino acid, or protein (diet) given is available for protein replacement and not used for energy requirement.

The subjects used in these experiments had been, as a general rule, on fairly adequate diets before shock was sustained; it is likely, therefore, that their protein stores were at fairly normal levels. In them, as we have seen, plasma volume and total circulating protein restoration was slow (three to four days). The problem of protein replacement with this group is real, but would have been quite serious if their daily protein intake had been, say, from 30 to 40 Gm. per day, for months prior to injury. Such persons, as now must exist by the thousands in occupied Europe at this time, barely maintain a level of plasma volume to ensure only fair circulation. In such persons injuries accompanied

by blood loss (shock) will present almost insurmountable problems in restoration of blood volume after injury.

In addition, restoration of plasma volume and total circulating protein from adequate stores in our subjects was not complicated by the problem of infection. In protein-depleted persons, such as those in occupied Europe, or our own troops in the forward areas for great lengths of time, on insufficient protein rations, protein must be made available in the early days after injury not only to restore plasma volume but also to replace the protein matrix of the cell so that there exists in the injured person adequate capacity to produce antibodies (globulins) to combat infection (see Cannon[8]). Perhaps one of the main beneficial effects of blood transfusions after injury or a surgical operation is the restoration of this cellular capacity to produce antibodies.

In certain forward areas of combat where there are many traumatic shock patients, the supplies of plasma will be sorely taxed for the early and immediate treatment of shock. Not enough plasma will remain to restore fully the plasma volume to normal levels. When adequate plasma volume replacement cannot be accomplished because of inadequacy of supply, medical officers caring for individuals after immediate recovery from shock should take every precaution to change the patient's position with great care. If possible, transport should be carried out with the patient in the head-down position (except possibly head and chest wounds). If a surgical operation must be done, careful judgment should be exercised in the choice and administration of the anesthetic.

In our more recent enthusiastic acceptance of plasma infusions in the therapy of traumatic shock, surgeons have tended to forget that red blood cells, as well as plasma, are lost from the blood stream in traumatic injuries. Reference to Figs. 1 to 6 shows that there are apparently no reserves of red cells available for replenishment either in the case of emergency or for three to four days following trauma. Therefore, proper replacement therapy for shock caused by trauma or acute hemorrhage calls for whole blood, not plasma alone. Plasma should be given as an emergency measure, to be followed soon after by whole blood in amounts quantitatively to replace the red blood cells lost; otherwise, secondary anemia will be present invariably in all traumatic shock patients for days after the injury. Plasma protein is replaced in the immediate period only slowly after shock, red blood cells hardly at all. This may indicate a selective priority of protein stores for the production of plasma protein, rather than for the elaboration of hemoglobin.

SUMMARY AND CONCLUSIONS

1. Loss of blood or plasma in traumatic shock is associated with only a slow restoration of plasma volume. Three to four days may be required for the attainment of normal plasma volume levels.

2. After shock, the plasma volume is not restored to normal until new plasma protein is drawn into the circulation. Plasma volume is not restored after shock by replacement with protein-poor fluids withdrawn from the extravascular system.

3. There are apparently no red cell reserves available for replenishment of red blood cells lost in traumatic shock, either immediately or for three to four days after the injury.

4. The proper therapy for traumatic shock after the emergency treatment with plasma requires the administration of adequate amounts of whole blood to replace red blood cells lost.

The authors wish to acknowledge the wholehearted support of Dr. I. A. Bigger, Chief of the Surgical Service, Medical College of Virginia, for providing the clinical facilities that made this study possible.

REFERENCES

1. Keith, N. M.: Blood Volume Changes in Wound Shock and Primary Hemorrhage, IX, Medical Research Committee Reports, London, 1919.
2. Evans, E. I., Hoover, M. J., James, G. Watson, III, and Alm, T.: Studies on Traumatic Shock: I. The Relation of Blood Volume to Shock, Ann. Surg. **119**: 64, 1944.
3. Ebert, R. V., Stead, E. A., and Gibson, J. G., Jr.: Response of Normal Subjects to Acute Blood Loss, Ann. Int. Med. **68**: 578, 1941.
4. Ebert, R. W., Stead, E. A., Jr., Warren, J. V., and Watts, W. E.: Plasma Protein Replacement After Hemorrhage in Dogs With and Without Shock, Am. J. Physiol. **136**: 299, 1942.
5. Gibson, J. G., II, and Evelyn, K.: Clinical Studies of Blood Volume, J. Clin. Investigation **17**: 153, 1938.
6. Kagan, B. M.: A Simple Method for the Estimation of the Total Protein Content of Plasma and Serum, J. Clin. Investigation **17**: 373, 1938.
7. Elman, R., Weiner, D. O., and Bradley, E.: Intravenous Injections of Amino-Acids in Postoperative Patients, Ann. Surg. **115**: 1160, 1942.
8. Cannon, P. R.: Antibodies and Protein Reserves, J. Immunol. **44**: 107, 1942.

CARDIOPULMONARY DISTURBANCES ASSOCIATED WITH MEDIASTINAL DISPLACEMENT AFTER PNEUMONECTOMY

HERBERT C. MAIER, M.D., MED. SC.D., NEW YORK, N. Y.
(From the Department of Surgery, Columbia University)

MEDIASTINAL displacement in the early postoperative period after total pneumonectomy may cause clinically significant alterations in the cardiocirculatory and respiratory function. Repeated adjustments of the intrapleural pressure on the side operated upon may be necessary in some cases in order to maintain a relatively median position of the mediastinum during the first few weeks after pneumonectomy. The present report is concerned with the causes, the effects, and the control of significant mediastinal deviation shortly after the operative procedure. The later effects of pneumonectomy on cardiopulmonary function have been previously reported by Cournand and Berry,[1] and by Lester, Cournand, and Riley.[2]

The mediastinum may be shifted to the side operated upon because of a highly negative pressure in the pleural space from which the lung was removed, or the mediastinal partition may be displaced toward the contralateral side by a large amount of air or fluid on the side of the operation. The time factor is very important in evaluating the effect of mediastinal displacement. Whereas a shift of the mediastinal partition which occurs gradually may cause few or no symptoms, and result in only slight cardiopulmonary maladjustment, a similar degree of displacement occurring rather suddenly may cause serious alteration in the respiratory and cardiocirculatory function. It is of the utmost importance that the degree of mediastinal displacement be minimized in the early postoperative period after total pneumonectomy, especially in the elderly and poor-risk group of patients. Intrapleural pressure readings must be taken at the conclusion of the operative procedure and at intervals in the postoperative period. In addition, roentgenograms should be taken on the first or second postoperative day, and then at intervals of a few days. Roentgen examination is the only certain way of determining the degree of mediastinal displacement due to fluid accumulation on the side from which the lung was removed.

Several factors will determine the amount of air which is trapped in the pleural space at the time the thorax is closed without drainage after pneumonectomy. The position of the mediastinum may be influenced by (1) the position of the patient on the operating table, (2) the degree of

Read at a meeting of the Society of University Surgeons, Chicago, Ill., Feb. 11-13, 1943.
Received for publication, Oct. 3, 1943.

inflation of the remaining lung, (3) the amplitude of the respiratory and mediastinal excursion at the time the thorax is closed, and the phase of respiration in which the sutures are tied which render the closure of the chest wall airtight, and (4) whether the thoracic incision acts like a sucking wound when it is almost closed. If closed drainage is employed the problem is altered, but other additional factors must be considered.

If the pneumonectomy has been performed through an anterior approach with the patient lying in the supine position, there tends to be little deviation of the mediastinum to the contralateral side during quiet breathing while the pleural cavity is open. This factor tends to favor a median position of the mediastinum at the time that the chest wall is closed after a pneumonectomy performed through an anterior approach, and the intrapleural pressure on the side operated upon is, therefore, usually nearly atmospheric or slightly subatmospheric. In contrast to this is the situation encountered when the patient is operated upon in the lateral recumbent position where there is a greater tendency for the mediastinum to be displaced to the opposite side and to limit the expansion of the dependent lung, and there is a tendency to trap more air in the pleural space when the chest wall is closed.

The anesthetist controls the degree of inflation of the remaining lung, which in turn affects the position of the mediastinum. The amount of air left in the pleural space on the side operated upon, as the thoracic wall is closed, will be influenced by this factor.

If the patient is breathing quietly at the time the thoracic wound is rendered airtight, the chance of trapping much excess air within the thorax is minimized. If a large respiratory excursion is present and the final sutures which make the wound airtight are tied during or at the end of inspiration, considerable additional air may be trapped within the pleural space.

As the thoracic wall is being closed after an intrapleural procedure it is not uncommon to have the effect of a sucking wound until the closure has been rendered airtight. The opening between the sutures may permit the entrance of air into the pleural space during inspiration but only permit a small portion of this air to be expelled during expiration. The maintenance by the anesthetist of a slightly positive intratracheal pressure during the closure of the thoracic wall does not eliminate the accumulation of air in the pleural space which may result from this sucking mechanism. By this means it is possible for considerable quantities of air to be trapped within the pleural space. If a large piece of well-moistened gauze is placed over the sucking areas of the chest wound, the entrance of air into the pleural space will be considerably diminished.

An intrapleural pressure, which is slightly subatmospheric when the patient is in the lateral recumbent position with the pneumothorax side upward, may be changed into a positive pressure when the patient is

placed with the pneumothorax side dependent. On several occasions a rather sudden drop in blood pressure and alteration in the character of the pulse have been observed when the patient's position was changed at the conclusion of a long intrathoracic procedure. It must be borne in mind that variations in intrapleural pressure which might not significantly affect the circulation of a normal individual, may seriously affect a patient verging on circulatory collapse. The poorer the general condition of the patient, the more important any abnormal alteration in intrapleural pressure may be. If the patient is in shock at the conclusion of an intrathoracic operation, the intrapleural pressure must be adjusted to an optimum level before the patient is even moved from the operating table, and again later if necessary. In recording intrapleural pressure readings the position of the patient must be taken into consideration.

When a pneumonectomy is performed without drainage, the position of the mediastinum is controlled by readings and adjustments of the intrapleural pressure by inserting a needle into the space from which the lung was removed. If drainage is instituted because of gross contamination of the pleural space when a pneumonectomy is performed for suppurative disease, a new problem may arise. It is customary in such cases to connect the drainage tube to a water seal. With this setup the patient tends to expel air from the pleural space, especially during coughing, and since no air can re-enter the pleural space because of the water seal, a markedly negative intrapleural pressure may result. The very negative intrapleural pressure may cause rather marked and rapid displacement of the mediastinum toward the side operated upon within the first few hours or days after pneumonectomy. The marked mediastinal deviation may cause a feeling of respiratory distress, and if uncorrected, may have serious and even fatal consequences. Several years ago we observed a patient who showed evidence of circulatory failure on the day following right total pneumonectomy with closed drainage. A roentgenogram taken shortly before the patient's death showed marked retraction of the mediastinum into the side operated upon. Post-mortem examination revealed marked congestion in the overdistended remaining lung. Sometime later another patient subjected to a left pneumonectomy with closed drainage presented a condition simulating shock a few days after operation. At this time the patient had a markedly negative intrapleural pressure on the side operated upon. The highly negative pressure was changed to a slightly subatmospheric pressure with a resultant dramatic improvement in the patient's condition. The following day a similar state of apparent circulatory failure developed and was again corrected by an adjustment of the intrapleural pressure. In a recent case in which drainage was instituted because of marked suppuration, the patient complained of respiratory distress on several oc-

casions within the first twenty-four hours postoperatively and this distress was relieved by making the intrapleural pressure less negative. It should be borne in mind, therefore, that although drainage following pneumonectomy usually eliminates the danger of a tension pneumothorax, it may lead to circulatory disturbances because of the extreme mediastinal deviation to the side of operation, which may occur as a result of the development of a markedly negative intrapleural pressure. The effects of closed drainage in total pneumonectomy are entirely different than in the case of a lobectomy where there is expansion of pulmonary tissue on the side operated upon, which greatly lessens the likelihood of significant mediastinal shift in the early postoperative period. If closed drainage is instituted following pneumonectomy, which as a matter of fact seems rarely necessary, the closed drainage should be so adjusted that not more than a given degree of negative pressure can develop in the system. In a few instances we have observed a markedly negative pressure develop the first few days after operation in the absence of closed drainage. In such instances, because of a poor closure of the deeper layers of the chest wall, a considerable portion of the air which had been left in the empty pleural space at the conclusion of the operation was forced into the tissue planes of the thoracic wall as a result of coughing. The effect was, therefore, much the same as if closed drainage had been employed. The few instances in which we observed this state of affairs were cases in which an anterior intercostal incision had been employed. With this surgical approach it is not possible to get a good closure of the pleural or intercostal muscles and therefore there may be considerable leakage of air into the chest wall. In two such instances several hundred cubic centimeters of air were introduced into the pleural space several days after operation in order to lessen the deviation of the mediastinum.

The more common situation is to note that the intrapleural pressure becomes less negative or even slightly positive in the first few postoperative days after pneumonectomy without drainage as a result of the transudation of considerable fluid into the space which the lung previously occupied. If the fluid accumulates at approximately the same rate as the air is absorbed or leaks into the chest wall, no significant deviation of the mediastinum occurs. If the transudation of the fluid is more rapid, however, the mediastinum may be displaced toward the contralateral side and the ventilation of the remaining lung may be impaired. Measurements of the pressure in the air pockets overlying the fluid do not give accurate information concerning the effect of the fluid accumulation on the position of the mediastinum. We have also found it rather difficult to judge accurately the position of the mediastinum on the basis of physical examination alone. We feel that it is important to ascertain definitely the position of the mediastinal partition by roentgenograms taken at intervals of several days. In one instance in which

the pleural fluid accumulation displaced the mediastinum to the opposite side there were certain clinical findings which suggested that a pericardial effusion might be the explanation of the patient's signs and symptoms, but removal of the excess pleural fluid resulted in a dramatic correction of the difficulties (Case 3). In another case the displacement of the mediastinum to the contralateral side by a large fluid accumulation was associated with a marked irregularity of the pulse. The cardiac rhythm became normal, however, shortly after the position of the mediastinum was corrected by thoracentesis (Case 4). In these two instances there was such a definite improvement in the cardiocirculatory function after the excess pleural fluid was withdrawn that there was no question of the causal relationship. Although it is obvious that considerable mediastinal displacement by fluid would seriously impair the function of the remaining lung, it should be stressed that the mediastinal deviation does not have to be marked in order to be clinically important. The introduction of sulfonamides into the pleural cavity at the time of operation may cause an increase in the amount of transudated fluid in the postoperative period and thus increase the likelihood of mediastinal displacement.

If the patient had no significant cardiocirculatory abnormality before operation, and if there is no emphysema in the remaining lung, the gradual displacement of the mediastinum to the side operated upon, which occurs postoperatively, usually causes no symptoms. If the remaining lung is emphysematous or cardiocirculatory abnormalities exist, the situation may be altered. In one instance a marked cardiac irregularity which occurred one week after pneumonectomy was dramatically corrected by the introduction of air on the side of the operation to lessen the mediastinal displacement (Case 1). In another case an emphysematous remaining lung became so hyperinflated as a result of displacement of the mediastinum to the side operated upon that the ventilatory function was seriously impaired. The patient showed a progressive fall in the per cent saturation of the arterial blood with oxygen during the first three weeks after operation. Usually the arterial oxygen saturation returns to a normal value within the first postoperative week after pneumonectomy.[3] There were signs of beginning circulatory congestion in the emphysematous lung when the mediastinum was replaced in the median line by the introduction of air into the pleural space from which the lung had been removed. Following this the patient's respiratory and circulatory status improved (Case 2).

ILLUSTRATIVE CASE REPORTS

CASE 1.—S. T. A right total pneumonectomy was performed on Sept. 16, 1942. The left lung had a moderate degree of pulmonary fibrosis and emphysema. The patient's condition during and at the conclusion of the operation was good. On the day following operation the arterial blood showed a normal oxygen saturation

of 95.6 per cent. On the second postoperative day the trachea and mediastinum were in the midline as determined by roentgen and physical examination. On the third postoperative day the trachea and mediastinum were slightly displaced toward the side operated upon due to the considerable amount of air which had escaped from the right pleural space into the chest wall. There was no respiratory distress and the arterial oxygen saturation was 98.6 per cent. On the sixth postoperative day the patient's general condition appeared good and there was no dyspnea or cyanosis, but the pulse was irregular although not rapid. An electrocardiogram was taken at this time and revealed marked irritability of the heart with a wandering pacemaker. On the following day, the cardiac irregularity had become even more pronounced. The mediastinum was only slightly displaced toward the side of the operation, but, nevertheless, a needle was inserted into the right pleural space, and 300 c.c. of air were introduced. An intrapleural pressure reading was not obtained before the introduction of air because fluid entered the needle, but following the introduction of the air the intrapleural pressure was -8, +1. Within approximately fifteen minutes of this readjustment of the mediastinal position the pulse became regular and remained regular throughout the postoperative period. No digitalis was given.

CASE 2.—D. M. This patient had a carcinoma of the left lung and marked bilateral fibrosis and emphysema. A left total pneumonectomy was performed on Nov. 23, 1940. The immediate postoperative condition was satisfactory. Although the patient's general condition during the first three weeks after operation was quite satisfactory, it was noted that there was a progressive drop in the arterial oxygen saturation from the preoperative level of 91 per cent to a low of 84 per cent in the third week after operation. Associated with this progressive oxygen unsaturation of the arterial blood, there was a gradual deviation of the mediastinum to the side operated upon and marked overexpansion of the remaining emphysematous lung. Râles were then noted in the remaining lung and it was thought by some that a low-grade bronchopneumonia was present. A determination of the residual air at this time yielded the very high value of 71 per cent, indicating the markedly overdistended condition of the remaining lung. It was felt that the mediastinum had to be returned to a more median position in order to permit the emphysematous lung to ventilate more satisfactorily. Therefore, air was introduced into the space from which the lung had been removed. The initial intrapleural pressure was -20, -8 and after 240 c.c. of air had been introduced the pressure reading was -8,0. Additional air refills were given on the following days. There was an immediate improvement in the patient's general condition and the râles cleared in the remaining lung. Nine days after the re-establishment of a pneumothorax on the side of the operation, the arterial oxygen saturation had returned to 91 per cent, which was essentially the same as the preoperative level, and there was an associated drop in the residual air and a marked improvement in the patient's respiratory and general condition.

CASE 3.—E. B. This 31-year-old man had a carcinoma of the left lung, and a total left pneumonectomy was performed on Jan. 27, 1940. The patient's condition a few days following operation was quite satisfactory. Two days after operation, the arterial oxygen saturation was 87 per cent. On the fifth postoperative day some irregularity of the pulse was noted. On the ninth postoperative day, the arterial oxygen saturation was 89 per cent, and the general condition fairly satisfactory. On the twelfth postoperative day the patient was quite dyspneic in spite of oxygen inhalations and a definite pulsus paradoxus was present. The venous pressure was 150 cm. of water. The possibility of a pericardial effusion was suspected. After the removal of additional pleural fluid from the side operated upon with correction of the mediastinal displacement to the other side, however, there was an immediate improvement in the patient's condition and the pulse rate again became normal in rate and quality. Actually no pericardial effusion was present.

CASE 4.—C. R. This 53-year-old man had carcinoma of the right lung, and a right total pneumonectomy was performed on Sept. 29, 1942. The postoperative course was satisfactory during the first days, although the temperature was somewhat higher than usual. On the fourth postoperative day an irregularity of the pulse was noted. A roentgenogram at this time showed some displacement of the mediastinum to the side unoperated upon as a result of a large fluid accumulation on the operated side. Removal of the excess fluid with a return of the mediastinum to a more median position resulted in a return of the pulse rhythm to normal within a few hours. No further difficulty was encountered in the postoperative period.

DISCUSSION

In an attempt to evaluate the detrimental effects and the clinical significance of any alterations in intrathoracic mechanics, the status of the cardiorespiratory system and the patient's general condition must be taken into consideration. Moderate mediastinal displacement, which might be of no serious importance in an otherwise normal individual, may have marked detrimental effects at the conclusion of a long operative procedure when there is reduction in blood volume and impairment of respiration and circulation. Therefore, an effort should be made to minimize alterations in intrathoracic pressure. Further investigation is necessary to clarify the details of the mechanisms by which moderate mediastinal displacement causes alterations in cardiocirculatory function.

Experimental work on dogs has little application to the problem under discussion. Because of different anatomic and physiologic arrangements in the canine, the remaining lung may be hyperinflated to fill the major portion of the thoracic cage immediately after pneumonectomy without causing any significant disturbance.

In this communication, the position of the mediastinum has been stressed. Reference has not been made to the detrimental effects of a positive intraplural pressure itself aside from its influence on the position of the mediastinum. In referring to circulatory changes associated with mediastinal displacement, the effect of the intrapleural pressure on the great veins and heart is included. Unless the mediastinum has been fixed by an inflammatory process, the position of the mediastinum is an approximate index of the intrapleural pressure after pneumonectomy. It is not a sufficiently accurate indicator of the pleural pressure, however, to be relied upon just after operation. Small amounts of air may cause a considerable alteration in the intrapleural pressure. Immediately postoperatively the intrapleural pressure should always be determined by manometer readings and the pressure should be adjusted to a slightly subatmospheric level.

CONCLUSIONS

Mediastinal displacement in the early postoperative period after pneumonectomy may cause disturbance of the cardiocirculatory and pulmonary function. The clinical significance of a given degree of

mediastinal deviation is greatly influenced by the preoperative cardiopulmonary function and the postoperative condition of the patient. The position of the mediastinal partition and the intrapleural pressure should be carefully adjusted in the postoperative period.

REFERENCES

1. Cournand, A., and Berry, F. B.: The Effects of Pneumonectomy Upon Cardiopulmonary Function in Adult Patients, Ann. Surg. **116**: 532, 1942.
2. Lester, C. W., Cournand, A., and Riley, R. L.: Pulmonary Function After Pneumonectomy in Children, J. Thoracic Surg. **11**: 529, 1942.
3. Maier, H. C., and Cournand, A.: Studies of the Arterial Oxygen Saturation in the Postoperative Period After Pulmonary Resection, SURGERY **13**: 199, 1943.

ROENTGENOGRAPHIC DIAGNOSIS OF TORSIONAL DEFORMITIES IN TUBULAR BONES

HENRY MILCH, M.D., NEW YORK, N. Y.

IN THE roentgenographic diagnosis of the relative positions of the upper and lower extremities of long bones, three types of displacement may be recognized; (1) angulational, (2) translational, and (3) rotational or axial.

The first, characterized by angulation of the longitudinal axes of the opposite ends, is readily recognized on anteroposteroir or lateral roentgenograms as a typical valgus, varus or bowing deformity. The second, characterized by parallel displacement of their respective axes, is similarly easily identified on routine roentgenograms taken at right angles. The third, or rotational displacement, often presents the utmost diagnostic difficulty, although its recognition is not infrequently of primary importance in establishing the indications for treatment. This is true in the treatment of fractures, recent or malunited, of anteversion of the femoral neck, of coxa anteverta, of resistant cases of clubfoot, and other conditions.

Commonly, the determination of rotational displacement depends upon exposure of the whole bone to roentgen beams which diverge from each other by known angular amounts. This method affords an excellent opportunity for the scientific measurement of the degree of rotation of a known anatomic prominence such as the femoral neck. However, this method is not always conveniently applicable, particularly when there has been a loss of continuity in the shaft of the bone. From a practical point of view, it is seldom, if ever, necessary to determine the degree of such rotations with mathematical precision, provided its direction can with accuracy be demonstrated. In this endeavor, a few simple observations have been found very helpful.

In recent fractures the presence of rotation of one fragment upon the other around a longitudinal axis must be envisaged when a disproportion persists between the fracture ends (Fig. 1). In the absence of any marked telescoping of the bone ends, this appearance can arise only from a rotational displacement, since long bones are, in general, irregularly polygonal or elliptical, but almost never truly circular in outline. As a consequence, the magnitude of their diameters or transverse axes will vary so that it is possible to define a largest or major axis and a smallest or minor axis. Anatomic reduction must, of course, include restoration of length, re-establishment of longitudinal alignment, and control of rotation, so that the major axis of one fragment coincides with the major axis of the other fragment. Provided the first two con-

Received for publication, Oct. 20, 1943.

ditions are satisfied, any steplike or cross-sectional disproportion between the transverse axes at the site of a fracture necessarily indicates that a small diameter of one fragment has been juxtaposed to a long diameter of the other fragment and that, therefore, rotation has not been corrected.

Fig. 1.—Anteroposterior and lateral views of a femur in which fracture of the lower third has been produced by osteotomy. The lower fragment has been rotated 90 degrees in relation to the upper. The longitudinal alignment is excellent, but the steplike disproportion in diameter at the site of osteotomy betrays the rotational displacement.

Failure to recognize the presence of rotation may account in no small measure for the difficulty experienced in the treatment of spiral or malleolar fractures of the tibia, fractures of the femoral neck, and especially supracondylar fractures of the humerus. In the latter case, the thinness of the bone in the supracondylar region makes the retention of end-to-end reduction most precarious and it is probably because of the persistence of some rotation that more marked displacement can be avoided. On the other hand, recognition of the situation is a clear indication to desist from any manipulative efforts other than those designed to correct excessive rotational deformity.

In Fig. 2 *A*, an osteotomy simulating a supracondylar fracture has been produced and the lower end has been rotated externally. On the anteroposterior view an excellent reduction seems to have been accomplished, but the lateral view discloses what might be mistakenly considered a posterior displacement of the upper fragment. However, any

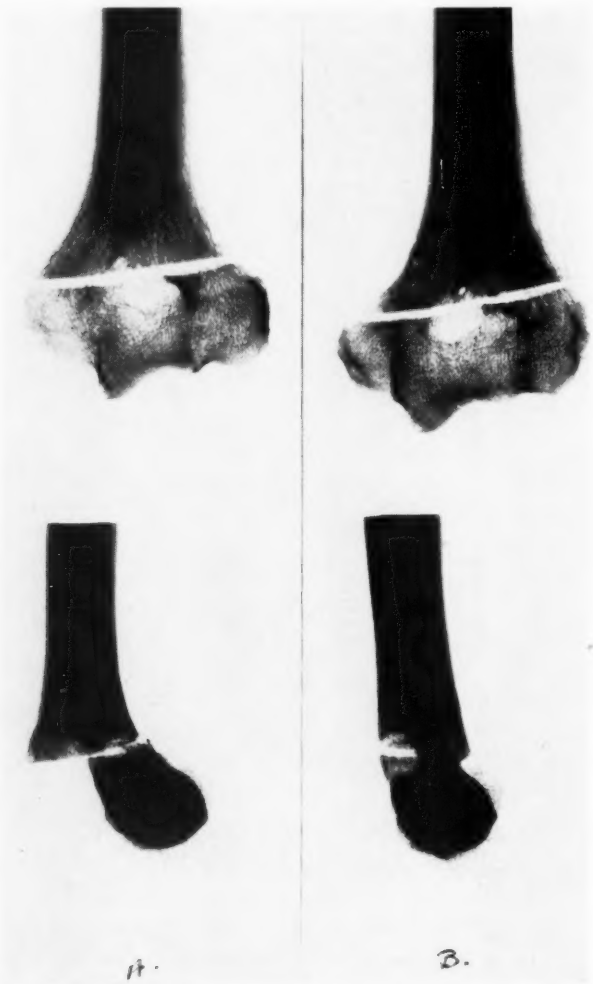


Fig. 2.—*A*, Supracondylar osteotomy, external rotation of distal fragment; anteroposterior alignment excellent. Lateral view shows what appears to be posterior projection of the upper fragment. *B*, Anteroposterior view showing what appears to be excessive medial displacement of the lower fragment, but produced as a result of internal rotation alone. Both are betrayed by cross-sectional disproportion.

effort to displace either fragment in an anteroposterior plane would be valueless and might be harmful. From the bony disproportion, with a posterior step existing at the fracture site, it is evident that only internal rotation of the lower fragment will suffice to correct the malalignment. Similarly, in Fig. 2 *B*, the appearance of a disproportion on the anteroposterior view indicates the presence of internal rotation, rather than excessive medial displacement of the lower fragment.

Although the existence of rotation can, with assurance, be established by the presence of such "cross-sectional incongruence," the direction of rotation can only be determined by other observations. These are based upon the principle which has already become familiar in the roentgenographic estimation of the angle of anteversion of the femoral neck. Essentially, the principle here utilized is that of determining the projection relationships between two transverse axes, which normally converge at known angles. In the case of the femur, these are the bicondylar axis and the axis of the femoral neck. A haphazard view of a foreshortened neck of the femur would give no valid information by which rotation of the femur as a whole could be differentiated from torsion within the course of the femur. However, if it were specifically stated that the knee was directed forward in a standard roentgenographic position and that, consequently, the bicondylar axis was transverse, the appearance of the upper end of the femur would immediately become of diagnostic significance. Combined with a capital shadow and a foreshortened lesser trochanter, the foreshortening of the femoral neck would justify the assumption of an internal torsion, such as is seen in congenital dislocation of the hip. Combined with a subcapital shadow and an enlarged lesser trochanter, it would justify the assumption of external rotation, such as is seen in coxa anteverta.[1, 2]

Using the direction of any normal bony projection as an axis of reference, the same method for the determination of torsion can be applied to all the long bones. Once the normal angular relationship of the prominence to any other transverse axis is known, torsion existing between the two axes can be roentgenographically established and, if necessary, readily measured. However, it is essential that the whole bone be radiographed on a single plate. Unless both axes of reference are projected on the same roentgen plate, it is impossible to draw anything but inference as to the presence or direction of any existent torsional deformity. The ease with which torsional deformities can be visualized will, of course, depend upon the length of the transverse axis used for reference.

In the humerus, the lower or bicondylar axis is preferable to the upper axis, because of the shortness of the humeral neck. In the humerus, in direct contrast to the femur, the axis of the head and neck is retroverted and makes a backward and inward opening angle of about 20 degrees. On the anteroposterior view, the bicondylar axis presents its greatest projection, but the head and neck are foreshortened (Fig. 3, *A* and *B*). An oblique view, taken with the humerus in 20 degrees of external rotation, shows the longest profile of the head and neck, but the bicondylar axis appears foreshortened (Fig. 3 *C*). It is only when the lower half of the osteotomized humerus is rotated internally through an angle of 20 degrees that both the axis of the neck and the bicondylar axis become parallel and simultaneously project at their greatest length (Fig. 3 *D*).

Because of the great range of motion possible at the shoulder joint, even marked torsional changes may be easily compensated without attracting any special attention. In the forearm, however, this is not the case. Here much slighter torsional deformities may lead to noticeable limitation of pronation and supination, and it may become a matter of prime importance to differentiate between limitation of motion due to soft tissue contracture, to joint pathology, or to torsional changes in either of the forearm bones. Fortunately, the normal presence of lateral projections on each of the forearm bones permits recognition of torsional changes with comparative ease.

A. *B.* *C.* *D.*

Fig. 3.—*A* and *B*, Normal humerus anteroposterior and lateral views. The head and neck project posteriorly and medially. *C*, 20 degrees external rotation; the neck is seen in maximum profile, but the bicondylar axis is foreshortened. *D*, Osteotomy and 20 degrees internal rotation of lower end; both the bicondylar axis and the axis of the neck are seen in maximum profile. Note step formation at side of osteotomy, indicating cross-sectional disproportion.

Examination of the ulna discloses that in its anatomic position the coronoid process points almost directly forward, while the styloid process, at its distal end, points almost directly backward. Its bony projections are best seen on lateral view and largely disappear on anteroposterior view. This is clearly visualized on the lateral roentgenogram of the ulna (Fig. 4 *A*). The forward projecting coronoid process and

the backward projecting styloid process are both seen in profile. On the anteroposterior view (Fig. 4 *B*), the coronoid and styloid process both become foreshortened and are hidden from view, beneath the shadow of the long axis of the bone. When the bone is osteotomized and the lower end rotated through 90 degrees, combination pictures are obtained. On the lateral view (Fig. 4 *C*) the coronoid process is seen as in the normal, but the styloid process assumes the position characteristic of its normal anteroposterior view. On the anteroposterior view (Fig. 4 *D*) the styloid process assumes the position characteristic of its normal

Fig. 4.—*A*, Normal ulna, lateral view. The coronoid process projects forward, the styloid process projects backward; both are seen in profile. *B*, Normal ulna, anteroposterior view. Both the coronoid process and the styloid process are foreshortened and are largely hidden in the shadow of the long axis of the bone. *C*, Lateral view of twisted ulna. The lower end of the ulna has been rotated 90 degrees after osteotomy; at its upper end the coronoid process presents its normal forward projection. The styloid process, however, is hidden and presents the appearance typical of a normal anteroposterior exposure. *D*, Anteroposterior view of twisted ulna; at its upper end the coronoid process is hidden, but the styloid process presents the appearance characteristic of a lateral exposure.

lateral exposure, while the coronoid presents its normal anteroposterior appearance. It follows, therefore, that the clear outline of the styloid process on a routine anteroposterior view and its absence on a routine lateral view are pathognomonic of torsion in the ulna.

A. *B.* *C.* *D.*

Fig. 5.—*A*, Normal radius, anteroposterior view; The bicipital tuberosity projects medially, the styloid process projects laterally. *B*, Normal radius, lateral view; both the bicipital tuberosity and the styloid process are foreshortened, so that they are hidden in the shadow of the long axis of the bone. *C*, Anteroposterior view of twisted radius; the upper end presents its normal appearance, but the lower end is typical of a normal lateral view. *D*, Lateral view of twisted radius; the upper end presents its normal appearance, but the lower end is characteristic of a normal anteroposterior view.

In the radius, the situation is exactly opposite. Because of the fact that in the anatomical position the bicipital tuberosity projects medially and the radiol styloid process projects laterally, its projections are best seen on anteroposterior view, while on the lateral view they become minimal. The normal anteroposterior roentgenogram reveals the medial projection of the bicipital tuberosity and the lateral projection of the styloid process (Fig. 5 *A*). On the lateral view, both these processes

tend to disappear (Fig. 5 *B*). As in the ulna, the anteroposterior view, following rotation osteotomy, yields combination pictures. The anteroposterior view discloses a normal upper end, while the lower end is typical of a normal lateral roentgenogram (Fig. 5 *C*). The lateral view discloses a normal lateral view of the upper end with a normal anteroposterior view of the lower end (Fig. 5 *D*). The absence of the radial styloid process in a routine anterposterior view and its presence on a routine lateral view are pathognomonic of torsion in the radius.

Normally, the radial styloid will best be visualized in the position in which the bicipital tuberosity is seen at its maximum. Similarly, the ulnar styloid will be seen at its maximum in the position in which the coronoid makes its longest projection. These facts make the determination of a torsional deformity possible, regardless of the relative positions of the bones at the time the roentgenogram is made. In complete supination, an anteroposterior view of the forearm will disclose both radial prominences and neither ulnar prominence, while on the lateral view the reverse situation will be seen. In midpronation (90 degrees), the anteroposterior view will disclose the normal anteroposterior view of the ulna, with a normal lateral view of the radius. In consequence, none of the four bony projections will be seen normally. However, on the lateral view (Fig. 6), all four projections will be visualized. The significance of this observation in the prevention of malunion is apparent and is well illustrated in the following case.

John M., aged 25 years, was referred for the diagnosis of a left forearm deformity: difficulty in turning his palm upward. This had developed after an injury at the age of 10. The patient did not know exactly what had happened, but he believed he had suffered a fracture, because his arm was in plaster for about a month.

Examination disclosed a fairly straight forearm, with what appeared to be an increase in the carrying angle. Flexion and extension were completely normal. Pronation could be performed to 50 degrees from the neutral position, but supination was possible to only 10 degrees beyond the neutral. The wrist and finger motions were normal. There was no evidence of motor or sensory disturbance in the hand or fingers.

Clinically, it was impossible to establish whether the limitation of supination was due to a pronation contracture, to disturbance at either radio-ulnar joint, or to some intrinsic bone change. In this dilemma, the roentgenogram necessarily taken in the flexed neutral position and not in the standard position, proved most enlightening (Fig. 7). The appearance of the upper ends of both radius and ulna on the anteroposterior and lateral views was quite normal. The fact that the radius was able to assume its normal supination position established the fact that the clinical limitation of supination was not arthrogenic or myogenic in origin. The appearance of the lower end, however, was most interesting. The ulnar styloid presented its normal appearance on both anteroposterior and lateral views. The radial styloid, on the other hand, presented its normal anteroposterior appearance on what was clearly a lateral view of the radial tuberosity and its normal lateral appearance on what was an anteroposterior view of the upper end. Apart from the bowing and disproportion in length, the radius was obviously the site of a marked pronation of the lower end in relation to its upper end.

In retrospect, it seemed justifiable to conclude that this patient had suffered a fracture of one or both bones of the forearm. The ulna, either unbroken or anatomically reduced, displayed its normal roentgenographic appearances. The lower end of the radius, however, was obviously reduced and fixed in relative pronation, while its upper end remained in supination. Although the longitudinal alignment was fairly satisfactory, the internal torsion of the lower radial portion resulted in inability to turn the palm upward, because the normal limitation of supination at the upper end prevented any compensating correction of the malalignment. Rotation osteotomy of the radius was advised, but has not yet been undertaken.

In the leg, because of the absence of prominent lateral projections, the roentgenographic recognition of torsion is somewhat more difficult. The

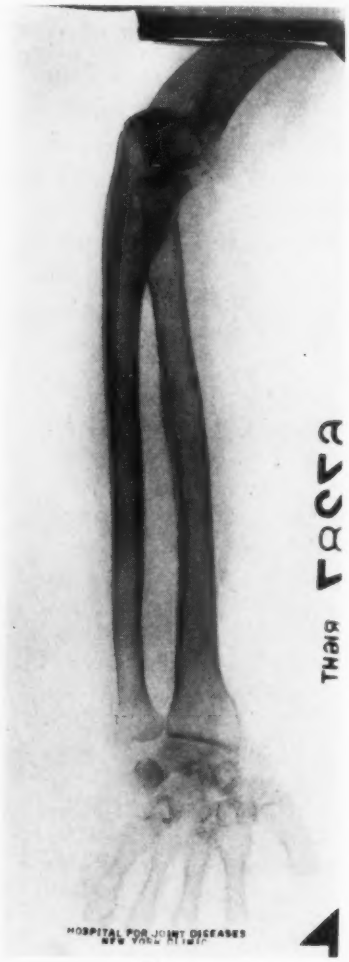


Fig. 6.

Fig. 7.

Fig. 6.—Lateral view of normal forearm in midpronation. All four prominences are readily recognized. In full supination the radial prominences would disappear.

Fig. 7.—John M. On the lateral view of the forearm the ulna presents its normal lateral appearance. The radius presents a combination form, the bicipital tuberosity is only slightly visualized, while the lower end presents a slightly oblique anteroposterior appearance. On the anteroposterior view of the forearm, the ulna presents its normal anteroposterior appearance. The upper end of the radius presents its normal anteroposterior appearance, but its lower end is typical of a normal lateral view, indicating a torsional deformity in the radius.

medial projection of the internal malleolus is so slight as to make it practically valueless for establishing an axis of comparison with the bicondylar axis of the tibia. However, the method here described can be employed with slight modification. The fixation of the fibula to the tibia justifies consideration of the external malleolus as a prominence on the lower end of the tibia. On a true lateral view, with the axis of

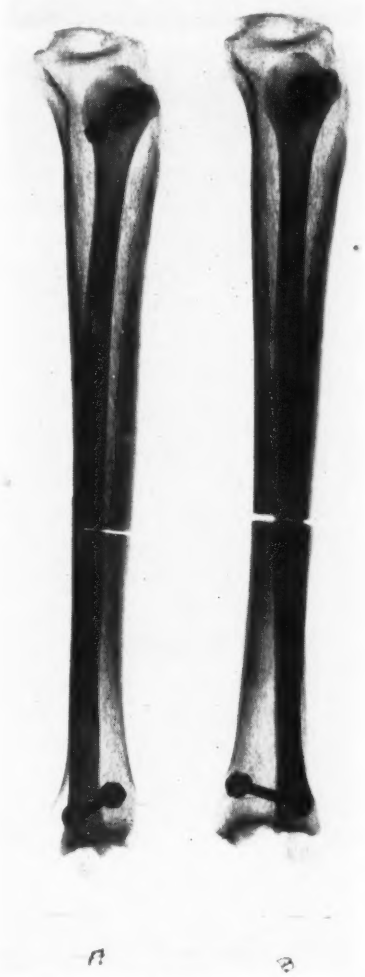


Fig. 8.—*A*, Lateral view of tibia and fibula; The axis of the fibula and the external malleolus lies just at the posterior margin of the tibia. *B*, Lateral view of osteotomized fibula and tibia. (Although not absolutely identical, the upper end of the tibia is essentially in the same position as in *A*.) The lower end of the tibia has been rotated internally. As a consequence, the shadow of this fibula has been displaced forward.

the knee joint perpendicular to the roentgen film, the long axis of the fibula normally lies posterior to the longitudinal axis of the tibia (Fig. 8 *A*). This is, of course, due to the fact that the bimalleolar axis of the ankle joint is normally externally rotated 20 to 25 degrees from the bicondylar axis of the tibia. Using this relationship as a norm, it will be seen that external torsion of the tibia serves to increase the apparent

backward displacement of the fibula on the lateral roentgenogram of the tibia. Internal torsion, on the other hand, results in a relative forward displacement of the malleolar shadow on the lateral view of the tibia (Fig. 8 *B*). The demonstration of this phenomenon, however, depends upon securing an absolutely true lateral view of the upper end of the tibia, as a norm, against which comparison may be made. Rotation of the upper end in either direction will, of course, result in a corresponding loss of relative movement of the fibular shadow in the opposite direction.

SUMMARY

The ends of a long bone may be displaced either along their longitudinal axis, across this axis, or around this axis. The determination of rotational or torsional displacements is more difficult and can only be made if special data is noted. Such data can be obtained by a study of the roentgenographic projections of normal prominences on the long bones. In the long bones of the four extremities, the presence of the normal anatomic prominence is noted and their roentgenographic appearance in critical positions is illustrated.

REFERENCES

1. Milch, Henry: Epiphyseal Coxa Anteverta, J. Bone & Joint Surg. **19**: 97, 1937.
2. Milch, Henry: Coxa Anteverta Versus Anteversion of the Femoral Neck, Bull. Hosp. Joint Dis. **4**: 79, 1943.

DERMA-FAT-FASCIA TRANSPLANTS USED IN BUILDING UP THE BREASTS

MORTON I. BERSON, M.D.*
NEW YORK, N. Y.

BUILDING up the contour of the breast after loss due to abscess, trauma, amputation, or faulty development can be accomplished successfully. In young and middle-aged women, complete or partial loss of a breast (see Figs. 1 and 2) produces a psychic effect on the individual and in many cases is a hindrance to their social and economic welfare, and, therefore, should be accorded considerable attention in reconstructive surgery. To produce a firm, symmetrical, and esthetic contour of the deformed breast, I have modified the technique by the use of the derma-fat-fascia transplantation.

OPERATION

Before the reconstruction is undertaken, the traumatic area must be free from any infection and completely healed. The recipient and donor areas are aseptically prepared and draped. A general anesthesia is preferable. A pattern is made over the existing normal breast to determine the amount of fat necessary to build up the contour of the deformed side. The amount of the fat transplant should be only slightly larger than the amount necessary to allow for the absorption. The site of the donor area is chosen from the lateral section of the gluteal region in order to obtain the necessary depth of the fat graft and the resulting scar will be covered by even scanty bathing costumes.

The pocket for the implant is made over the existing scar if there is one present from a previous operation. If not, the incision is made in the location of the inframammary fold. The skin, with the nipple attached, is extensively undermined to form a pocket large enough to receive the graft without tension. Hemorrhage must be controlled since the formation of a hematoma will cause a loss of the graft. Hemostasis is best effected by pressure with hot wet packs. These packs are left in situ while the graft is removed from the donor area. To lessen the operative time, an assistant can prepare the recipient area while the graft is removed at the same time.

The fat graft must be removed with a section of the derma and fascia intact. The pattern of the approximate amount of fat to be removed is marked over the donor area. The section of the derma to be left intact is outlined with a dye within that pattern. The epithelium is excised from that outlined section, the dermatome being used preferably to re-

Received for publication, Sept. 29, 1943.

*Director of Plastic and Reconstructive Surgery, The Downtown Hospital and Pan-American Clinic.

A. *B.*

Fig. 1.—*A*, Complete absence of breast tissue following removal of benign tumor. *B*, Corrected by derma-fat-fascia transplant inserted in a pocket made over the existing scar.

B.

A.

Fig. 2.—*A*, Deformed breast with adherent scar and loss of 1/3 of its tissue resulting in asymmetry of breasts. *B*, Scar excised, skin extensively undermined, and derma-fat-fascia graft implanted.

move it. In using the dermatome, the cement should be applied to the drum over a space similar in size to the outlined section of epithelium to be removed. The epithelium can also be excised with a sharp blade by applying traction over the skin.

Oblique incisions are then made along the outer margins of the de-epithelized area, deep through the base of the fat, to and including the layer of fascia so that the base has twice the area of the dermal region. The section of fat covered by derma and attached to the underlying

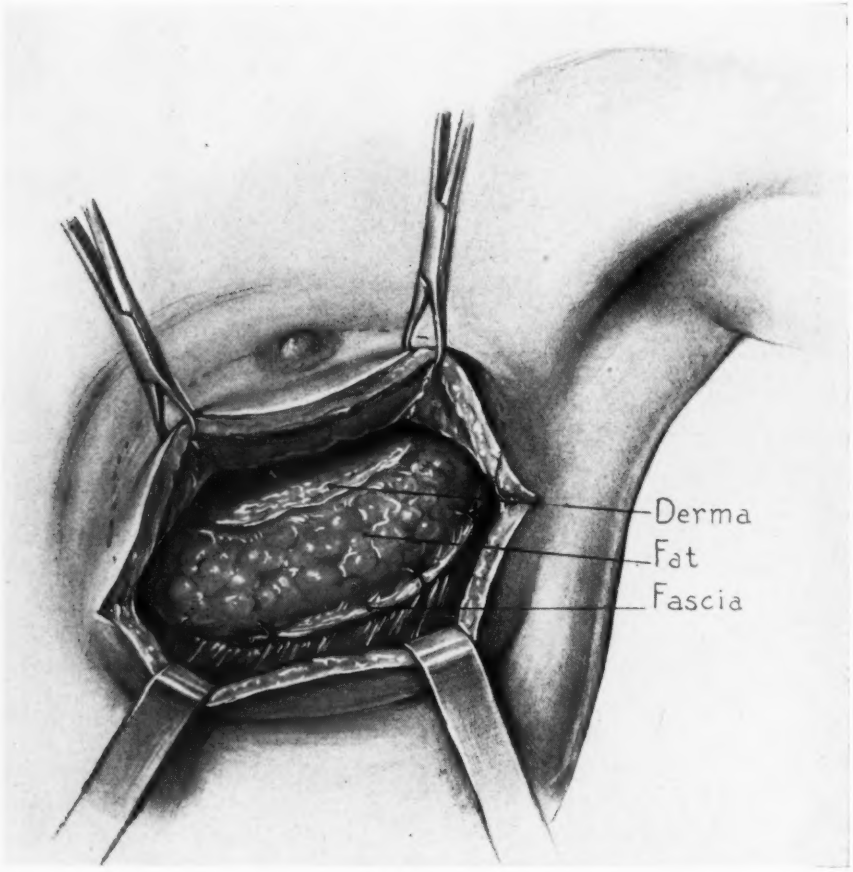


Fig. 3.—Diagram showing the position of the derma-fat-fascia graft.

fascia is gently cleared for the required distance by blunt dissection and the appropriate sized derma-fat-fascia graft is stripped from the underlying muscle in one section, since several sections will have a greater absorption tendency and will undergo more degeneration than a single large piece. Catgut anchor sutures are inserted at each end of the graft through the fat and derma. Hemorrhage in the donor area is controlled and the margins of the surrounding fat are undermined and approximated with catgut sutures so that the cavity is closed to obliterate dead spaces created by the removal of the graft. The skin margins are

approximated with fine interrupted silk sutures and a pressure dressing is applied.

The gauze pads are removed from the previously prepared pocket, which must be absolutely dry, and the fat graft held by the anchor sutures is introduced with as little handling as possible into the cavity and placed with the derma outermost directly under the flap of the skin (see Fig. 3), and anchored by the anchor sutures which are made to emerge through the skin at the distal ends of the pocket. The base of the

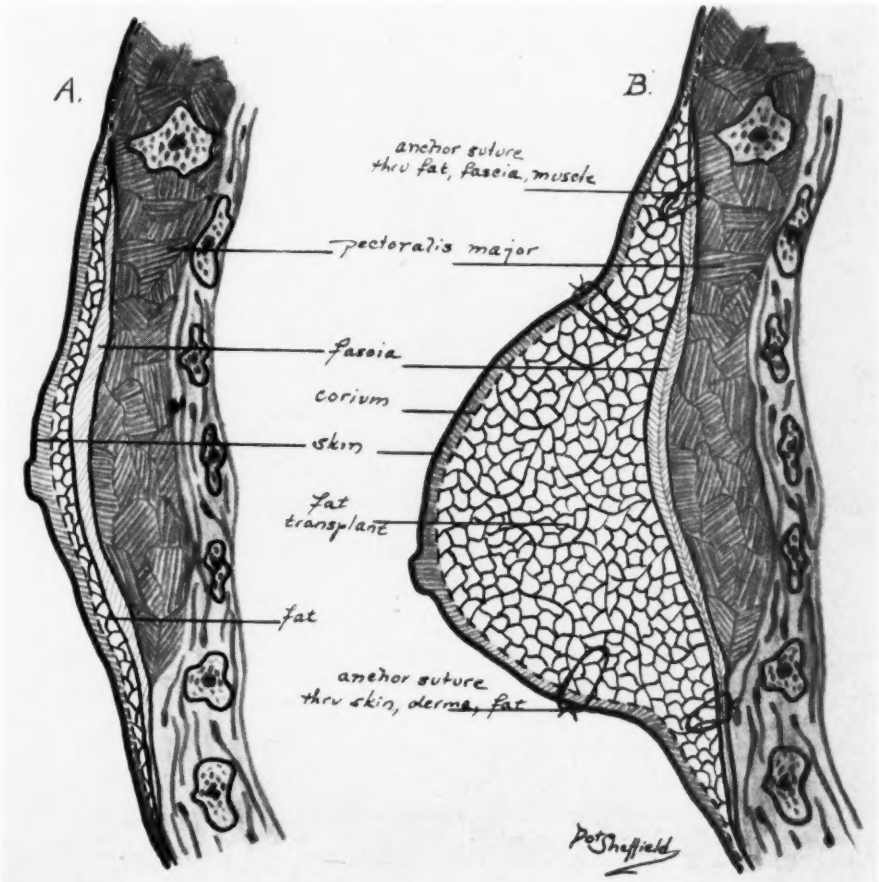


Fig. 4.—*A*, Sagittal section of deformed breast showing absence of breast tissue. *B*, Sagittal section of same breast showing derma-fat-fascia transplant anchored in place.

fat containing the fascia is curled and shaped to the desired roundness and is anchored to the fascia and muscles at the base of the chest (see Fig. 4). With the graft in place, the incision in the skin is closed accurately with fine interrupted silk sutures, drainage being omitted.

The dressing, consisting of large pieces of gauze, is placed around the base of the rebuilt breast thus producing an elevation at the center of

the breast with the pressure at the base. The patient must be taught to maintain immobility of the entire pectoral region for one week, at the end of which time the sutures are removed.

SUMMARY

I have found that a fat graft covered by a layer of derma on one side and fascia as its base will attach itself more firmly to the recipient base. Since this type of graft is easily invaded by capillaries, there is an increase in the vitality of the fat tissue and a tendency to regenerate most satisfactorily. This method reduces greatly the amount of absorption of the fat and renders the graft more resistant to infection. A derma-fat-fascia graft is more easily handled, gives better contour to the breast, and produces a firmer filler substance. Fat grafts without the attachment of the derma and fascia absorb at least from one-third to one-half of their volume. This method is more satisfactory than the pedicle flap method of rebuilding the contour of the breast as it eliminates extra stages of operation, unnecessary scarring, and the resulting contour is more esthetic.

Similar derma-fat-fascia transplants can be used in many other conditions such as depressions in the facial contours, depressed frontal areas, destroyed lower lips, and burns about the face. This method can also be used in transplantations around joints, brain and bone defects, and contractures around the hand. In these cases where the depressions are shallow, the derma-fat-fascia grafts can be acquired from the abdomen or thigh since the thickness of the fat in these areas corresponds more closely to the amount required in filling shallow depressions.

REFERENCES

Binnie, J. F.: Some Uses of Fat in Surgery, Surg., Gynec. & Obst. **18**: 336, 1914.

Davis, J. S., and Traut, H. F.: Plastic Surgery. Dean Lewis' Practice of Surgery, Vol. 5, Hagerstown, Md., 1930, W. F. Prior Company, Inc.

Douglas, J.: Fat Transplant for Adhesions After Tenorraphy, Ann. Surg. **71**: 791, 1920.

Gillies, H. D.: Plastic Surgery of the Face, London, 1920, Oxford University Press.

Gurney, C. E.: Experimental Study of the Behavior of Free Fat Transplants, SURGERY **3**: 679, 1938.

Kanavel, A. B.: The Transplantation of Free Flaps of Fat, Surg., Gynec. & Obst. **23**: 163-176, 1916.

Kanavel, A. B.: The Transplantation of Free Flaps of Fat, Tr. Am. S. A. **34**: 434-465, 1916.

Kanavel, A. B.: Transplantation of Fat, Fascia, and Living Tissue in Surgery. A Report of Experiences in Various Conditions, J. Missouri M. A. **14**: 333-340, 1917.

Key, B. W.: Fat Implantations, Arch. Ophth. **48**: 292, 1919.

Kirschner, M.: Uber freie Sehnen- und Faszientransplantation, Beitr. z. klin. Chir. **65**: 472-503, 1909.

Lexer, E.: Zwanzig Jahre Transplantationsforschung in der Chirurgie, Arch. f. klin. Chir. **138**: 251, 1925.

Roy, J. N.: War Surgery: Plastic Operations on the Face by Means of Fat Grafts, Laryngoscope **31**: 65-77, 1921.

AN IMPROVED CUTTING EDGE FOR THE PADGETT DERMATOME

Major Harris B. Shumacker, Jr., Medical Corps, U. S. Army

IT HAS become increasingly apparent, with the passage of years, that the use of free grafts of split sheets of skin of varying thickness has a most important place in the plastic repair of skin defects. Concomitant with the steady increase in the field of applicability of these types of skin grafts there have been developed a number of dermatomes which permit the accurate cutting of large split-skin grafts of suitable size and of uniform and desired thickness. Indeed these dermatomes have to a certain extent been responsible for the extended utility of the various types of split grafts.

The dermatome described by Padgett[1] has become widely used because of the ease with which its use is mastered and because of its dependability. It consists of a drum which is fixed to the skin with glue and to which is attached a movable knife blade which can be fixed at a definite measured distance from the drum, thus insuring the cutting of a sheet of skin of the desired thickness. It has enabled many surgeons to cut suitable grafts who were unable to do so with free plastic knives. In my hands its sole disadvantage has been the difficulty of keeping the blades sharp. This is especially a problem in rural areas and in army hospitals where facilities are not available for expert sharpening of knives. The dermatome presented by Poth[2] consists of a traction bar and needle retractors for maintaining uniform skin tension, and of a frame which carries a cutting edge and contains a mechanism for regulating the depth of cut. It yields most satisfactory results. Perhaps the most novel and useful feature of this dermatome is the cutting edge which consists of four safety razor blades fixed end to end in a holder. This insures a sharp knife which can be assembled anew for each use and eliminates the problem of dull blades and of efforts to sharpen them.

As I had used with satisfaction both the Padgett and the Poth dermatomes, it occurred to me that the utility of the former could be increased by incorporating the principle of the latter of using a series of safety razor blades in place of a formed plastic knife. Consequently, a very simple blade carrier was devised which can be used in place of the regular knife.

The regular knife is 16.3 cm. long and 2.5 cm. wide. At either end is a slot which fits over a pin attached to the arm of the drum. It is held in place by a metal cuff which fits over the frame and a portion of the blade. The new carrier (Fig. 1) is roughly the same size, shape, and thickness. It is 2.2 cm. in width. On one surface a depression is ground

Received for publication, Sept. 29, 1943.

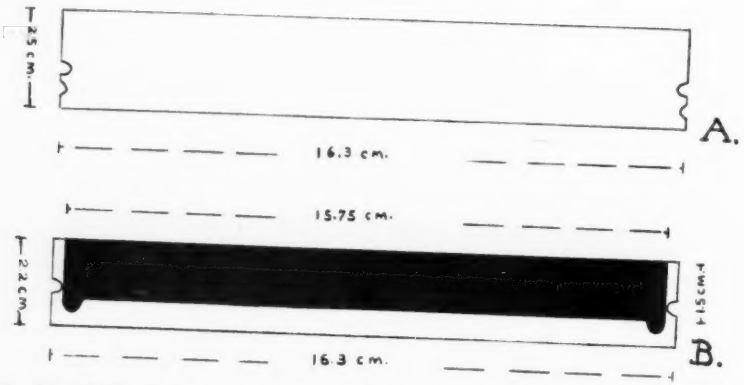


Fig. 1.—The dimensions of the regular knife (*A*) and of the blade carrier (*B*).

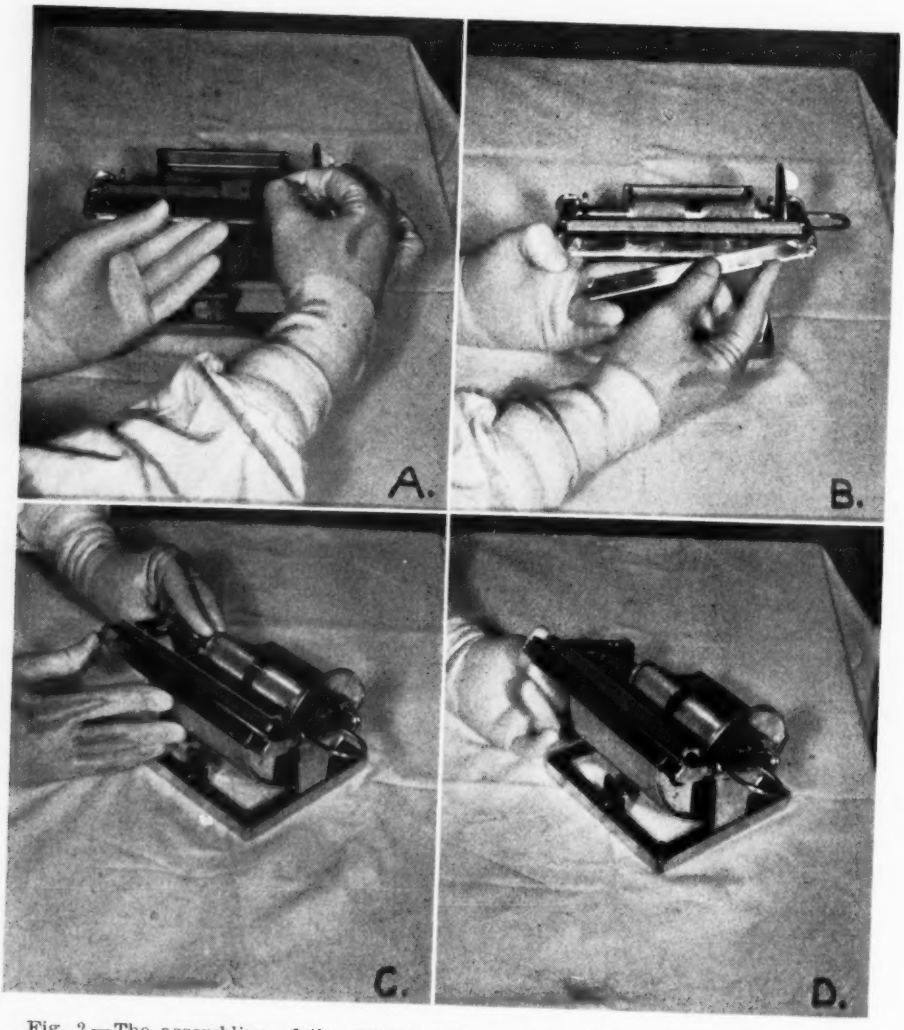


Fig. 2.—The assembling of the cutting edge. *A*, The blade carrier is in place and the razor blades are being slipped into position. *B*, and *C*, The razor blades are in position and the cuff is being placed over frame and carrier. *D*, The assembled cutting edge.

which is 15.75 cm. long, 1.5 cm. wide, and 0.2 mm. (8/1,000 inch) in depth. This depression is just long enough to permit four Valet razor blades to lie end to end within it. The razor blades are 1.8 cm. in width so that when placed properly in the depression their edge protrudes 0.3 cm. beyond the edge of the carrier, thus making the assembled cutting edge and carrier the same width as that of the regular knife. The razor blades are 0.25 mm. (10/1,000 inch) in thickness so that when they lie in place they rise 0.05 mm. (2/1,000 inch) above the surface of the carrier. When the carrier and metal cuff are in position the blades are held firmly in place between the carrier and the frame.

The dermatome and blade carrier are sterilized in the usual manner. The razor blades are cleansed carefully with ether and placed in some cold sterilizing solution. Before being used they are rinsed with saline solution or aqueous zephiran. The operator places the blade carrier on the frame and holds it firmly in place with the thumb and index finger of one hand (Fig. 2). With the other hand the four razor blades are slipped into place end to end in the slot between the carrier and frame. Care is taken to have the same surface of each blade up as the bevel is slightly different on the two surfaces of the razor blades. When they are placed properly the metal cuff is put on without difficulty. The entire manipulation takes only a moment.

This cutting edge has proved entirely reliable. It permits one to have with negligible expense a new sharp blade for each use of the dermatome.

SUMMARY

1. A new blade carrier is described for use with the Padgett dermatome which is easily constructed with little expense. It utilizes a series of safety razor blades in place of the regular knife, and makes possible a new sharp cutting edge for each use of the dermatome.

The author wishes to express his appreciation to Chief Machinist's Mate Emil J. Abrisch, U. S. N., who constructed the first blade carrier for him.

REFERENCES

1. Padgett, E. C.: Calibrated Intermediate Skin Grafts, Surg., Gynec. & Obst. **69**: 779-793, 1939.
2. Poth, E. J.: A New Technique for Cutting Skin Grafts Including Description of New Instruments, SURGERY **6**: 935-939, 1939.

OBSERVATIONS ON THE INTRACISTERNAL INJECTION OF POTASSIUM PHOSPHATE IN THE DOG

EDMUND A. SMOLIK, M.D., ST. LOUIS, MO.

(From the Department of Neurosurgery, Washington University School of Medicine)

THE physiologic responses to intraventricular injection of pituitrin and pilocarpine have been experimentally studied by Cushing.[1] Other investigators[2] had demonstrated that certain substances such as dyes, toxins, and neurotropic viruses produced no effect when injected into the blood stream, whereas when injected intracerebrally, intrathecally, and intraventricularly, active responses were obtained. The experimental evidence indicates that there is a "blood-brain barrier" and that this barrier is mediated through the capillaries of the central nervous system which are endowed with a selective permeability.

The recent work of Stern[3, 4, 5] on the direct action of potassium phosphate on the vegetative centers by intraventricular or intracisternal injection suggested their use in shock. By the single injection of small amounts of potassium phosphate into the cisterna magna, she and Chvoles[6] were able to bring the animal out of shock even when the shock was due to loss of blood. The resulting elevation of arterial pressure is attributed to the direct stimulation of the sympathetic centers by the potassium and depression of the parasympathetic centers through the decrease in ionization of the calcium by the phosphate ion. Favorable results in clinical studies on the battlefield were also obtained by the cisternal injection of 1 to 2 c.c. of the solution.

These encouraging reports suggested the possible use of potassium phosphate in restoring low blood pressures encountered during neurosurgical procedures where entry into the ventricles could be easily effected. The purpose of this study was to determine the action of potassium phosphate under various experimental conditions, especially hemorrhagic shock. The results obtained are the basis for this report.*

METHODS

Nine dogs were used, seven of which were subjected to varying degrees of hemorrhage from the femoral artery. Intravenous barbital anesthesia was employed in all experiments. The technique as outlined by Wiggers and Werle[7] for the production of *irreversible* shock was followed. In each instance in which hemorrhagic shock was produced, the dog was bled from one femoral artery so that a blood pressure level of 50 mm. was maintained for at least one hour and then further lowered to a level of

Received for publication, Oct. 23, 1943.

*A preliminary report was published in Proc. Soc. Exper. Biol. & Med. 53: 70, 1943.

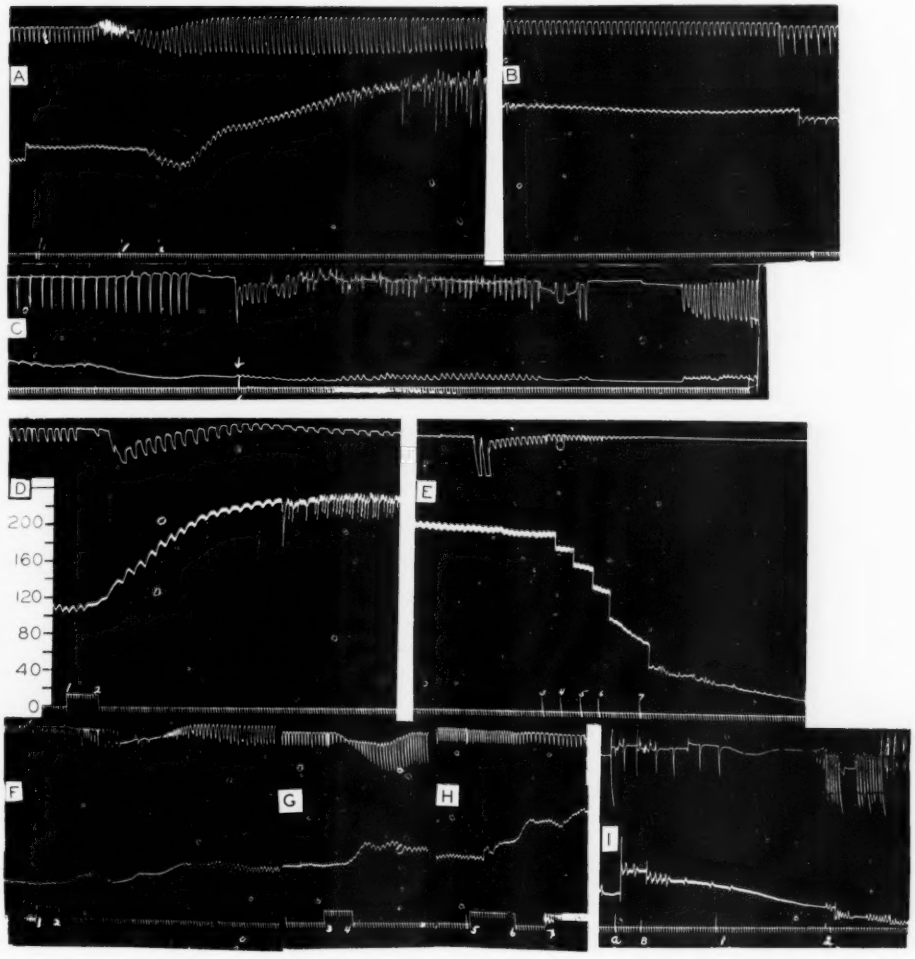


Fig. 1.—*A* and *B*. (In all figures the time is marked in seconds on the line of zero blood pressure.) This dog's weight was 15.2 kg., normal blood pressure, 116 mm. Between 1 and 2, 1 c.c. of potassium phosphate was injected intracisternally into an unbled dog. Elapsed time between *A* and *B* was 5 minutes.

C, This dog's weight was 6.5 kg. The dog was bled at the rapid rate of 322 c.c. in forty-five minutes. The blood pressure fell to 30 mm. Hg, at which point before the blood could be reinjected, respirations ceased. While artificial respiration was being given, 0.4 c.c. (arrow) of potassium phosphate was injected. There was no effect.

D and *E*, The dog's weight was 18.6 kg. Potassium phosphate, 2 c.c., was injected intracisternally into the unbled dog. (1 and 2.) The interval between *D* and *E* marks four minutes. There was a marked rise in pressure followed by a rapid fall and death due to respiratory and circulatory failure; *3*, *4*, *5* and *6* represent pauses of the drum for thirty seconds each.

F, *G*, and *H*, The dog's weight was 13 kg. This dog was bled rapidly 475 c.c. so that at (*1*) blood pressure fell to 36 mm. Immediately, without reinjection of blood (as in the Wiggers-Werle technique), 0.5 c.c. of potassium phosphate was injected (*1* and *2*) and again at (*3* and *4*) 0.4 c.c. was injected. There was a tendency for the pressure to drop, although only slightly, so at *5* and *6* blood was reinjected and blood pressure rose above normal.

I, The dog's weight was 15.4 kg.; this dog was bled 895 c.c. After having been held at shock levels for three hours the blood was reinjected; *a* indicates the end of the injection. The blood pressure rose but rapidly slipped. As respiration failed, artificial respiration was begun at *b*. At (*1*), 0.4 c.c. of potassium phosphate was injected. At (*2*), artificial respiration was begun and an additional 0.4 c.c. of potassium phosphate injected.

30 mm. Hg for 30 to 45 minutes. In all of these cases when the full amount of withdrawn blood was reinjected and no sustained rise in blood pressure was produced, the dog was considered to be in shock and the solution of potassium phosphate was then injected intracisternally.

Mean blood pressure was recorded with the mercury manometer from the other femoral artery and respirations by thoracic cage pneumograph and tambour. The solution consisted of $\frac{1}{6}$ molar (isotonic) solution of potassium phosphate (mixture of KH_2PO_4 and K_2HPO_4 brought to pH 7.6) as prepared by Stern.[4, 5] It was injected by cisternal needle with the dog's head in a lateral dependent position. Stern[4, 5] recommended 1 to 2 c.c. as the therapeutic dose for a 70 to 75 kg. man. Calculated on this basis, 0.4 to 0.5 c.c. was considered therapeutic for the 15 to 18 kg. dog. The amount of blood withdrawn varied from 10 to 60 per cent of the estimated blood volume.

COMMENT

In Fig. 1, *A* and *B* we obtained a positive response to intracisternal injection of potassium phosphate in a normal dog. There was first an inhibition of respiration and then acceleration. Blood pressure rose so rapidly and vigorously that the record shows carotid sinus slowing of the heart. Fig. 1 *C* is shown to illustrate the negative response obtained when the shock level was maintained according to the technique of Wiggers and Werle. Fig. 1 *D* and *E* demonstrates the sudden collapse after vigorous stimulation when about four times the calculated dose of potassium phosphate is injected. Fig. 1 *F*, *G*, and *H* illustrates the beneficial effect of intracisternal potassium phosphate and blood when the blood pressure is lowered for only a brief time. In Fig. 1, *I*, the blood (895 c.c.) had been reinjected but respiration had failed. Here at a higher level of blood pressure, even though artificial respiration is instituted, potassium phosphate fails to produce a favorable response.

DISCUSSION

In reviewing the work of Chvoles,[6] it is interesting to note that in the protocol of his experiment (one illustration), an 11 kg. dog whose initial blood pressure was at a level of 150 mm. was subjected to a fracture of the tibia and withdrawal of 250 c.c. of blood. This dropped the blood pressure to 60 mm. in the forty minutes involved in the procedures. Immediately 1 c.c. of potassium phosphate was injected and the dog manifested improvement which was maintained one hour and fifteen minutes later. The last recorded blood pressure was 170 mm.

This opens the question as to the validity of the criterion of the state of shock. In our experiments the dogs were bled according to the technique of Wiggers and Werle. Only when reinjection of all withdrawn blood failed to produce an effect was the dog considered in shock. Then potassium phosphate was injected intracisternally. Whenever the pres-

sure was above 50 mm. we obtained favorable responses. However, when the animal was in a precarious condition, injection of the phosphate was not only ineffective but apparently dangerous. Large doses (approximating four times the calculated therapeutic dose) resulted in dramatic rise in blood pressure but were followed within a short time by death due to failure of blood pressure and respiration.

The ionic effects of calcium and potassium when injected into muscle, for example, cardiac muscle, and into the peripheral circulation are usually in opposite directions. In general an increase of the K/Ca ratio produces the phenomena of parasympathetic stimulation. The opposite effect is obtained, namely, sympathetic (accelerator) stimulation, when there is an increase of the Ca/K ratio.

There is a reversal of these ionic effects, however, as demonstrated by Stern and co-workers and likewise shown in our experiments, when the potassium salts are injected intracisternally. With potassium phosphate we have obtained tremendous rises in blood pressure in normal animals and acceleration of pulse and respiratory rates. Animals in shock, however, did not respond uniformly. At times there was an increase in pulse rate and blood pressure, but in some instances the action was apparently depressant. In normal animals large doses produced spectacular stimulation which was followed by sudden collapse and death. Certainly the direct central action of potassium phosphate is remarkable. Its exact mode of action is not definitely known.

CONCLUSIONS

1. The intracisternal injection of small amounts of potassium phosphate (pH 7.6) in normal dogs stimulates respiration and pulse rate and produces marked elevation of blood pressure.

2. When injected in dogs subjected to hemorrhagic hypotension and shock the result is not uniform.

3. Large doses of potassium phosphate increase respiration, pulse, and blood pressure but may be followed by failure and sudden death.

ADDENDUM

In a recent article, C. B. Downman and C. C. Mackenzie (Lancet **245**: 471, 1943) report the effects of intracisternal potassium phosphate injection in rabbits. These investigators obtained rise of blood pressure, augmented respiration, and increased muscle tone following the injection but they found that these responses were not altered by previous hemorrhage. They obtained no permanent toxic effects following the injection.

I wish to express my thanks to Dr. Ernest Sachs for his interest and to Dr. Joseph Erlanger for his generous suggestions in carrying out this study.

REFERENCES

1. Cushing, H.: The Similarity in the Response to Posterior Lobe Extract (Pituitrin) and to Pilocarpine When Injected Into the Cerebral Ventricles, Proc. Nat. Acad. Sc. **17**: 171, 1931.

2. Friedemann, Ulrich: Blood-Brain Barrier, Physiol. Rev. **22**: 125, 1942.
3. Stern, L. S.: A propos de la methode d'action directe des substances chemiques sur les centres nerveux, Schweiz. med. Wchnschr. **71**: 367, 1941.
4. Stern, L. S.: Treatment of Shock by Direct Action on Vegetative Nervous Centers, Lancet **243**: 572, 1942.
5. Stern, L. S.: Treatment of Shock by Direct Action on Vegetative Nervous Centers, Brit. M. J. **2**: 538, 1942.
6. Chvoles, G. Y.: Role of the Hemato-Encephalitic Barrier and of the Cerebro-Spinal Fluid in Pathogenesis and Therapy of Shock, Sovet. vrach. zhur. **44**: 487, 1940.
7. Wiggers, C. J.: The Present Status of the Shock Problem, Physiol. Rev. **22**: 74, 1942.

TRAUMATIC PERFORATIONS OF THE SMALL INTESTINE DUE TO NONPENETRATING ABDOMINAL INJURIES

A Survey of Eighteen Cases

Bernard J. Ficarra, M.D.,* Brooklyn, N. Y.

(From the Kings County Surgical Division of Kings County Hospital)

INTRODUCTION

PERENNIAL interest in traumatic abdominal injuries has been manifested by the surgeon. In civilian life the automobile, heavy industry, and simple accidents produce innumerable intra-abdominal injuries. The advent of war has increased still further the interest in this subject. Among those organs injured subsequent to blunt trauma to the abdomen is the small bowel. The diagnosis of rupture of the small intestine is very difficult at times. It is hoped that the information gathered and reproduced here will be of assistance in facilitating the diagnosis of small bowel perforations. In those instances where the diagnosis is entertained, early operation will aid greatly in reducing the mortality caused by nonpenetrating trauma to the abdomen.

Traumatic perforations and rents of the small bowel occur when an unexpected blow strikes the abdominal wall. When a blow is received unexpectedly the muscles of the abdominal wall are not contracted. This lack of muscle "splinting" leaves the viscera unprotected and exposed to the full power of an assailing line of force. Therefore the abdominal viscera have little protection against injury under these circumstances. Usually the subcutaneous tissue and the abdominal muscles absorb the shock of blunt trauma, thus diffusing the power of a blow.

When the small intestine becomes the victim of trauma, there are several areas most often involved. These are the fixed segments: the duodenum, near the ligament of Treitz, and near the ileocecal region. When blows to the epigastrium injure the duodenum, the third portion is most frequently affected. This occurs because it is attached to the bodies of the upper lumbar vertebrae by peritoneum. A sudden striking force directed toward the epigastrium will drive the posterior wall of the duodenum against the surface of the vertebral bodies producing an injury to the duodenal wall. Bleeding may occur in some instances. The blood has been known to escape into the retroperitoneal spaces (Case 6). The same general factors produce rents in the vicinity of the ligament of Treitz. A potent force striking a segment of jejunum near this ligament moves the loop beyond its limit of mobility, thus

Received for publication, Oct. 3, 1943.

*Resident Surgeon, Kings County Hospital.

TABLE

CASE NO.	AGE	SEX	HISTORY	DURATION OF INJURY	ADMISSION DIAGNOSIS	X-RAY FINDINGS
1	49	M	Knicked in abdomen during a fight	24 hr. preop.	Perforated abdominal viscus	None taken
2	64	M	Thrown from an auto	6 days before admission	Paralytic ileus, bronchopneumonia, fractured ribs	Pneumonia of the left side, free air under diaphragm
3	38	M	Struck by auto, hematemesis present	12 hr. preop.	Perforated abdominal viscus	Free air present
4	75	M	Struck by auto	7 hr. from injury to death	Shock, multiple contusions, and abrasions	None taken
5	50	M	Kicked in abdomen during a fight	10 hr. preop.	Perforated abdominal viscus	No free air
6	14	M	Struck in epigastrium by handle bars of bicycle, hematemesis present	48 hr. preop.	Possible splenic injury	None taken
7	53	M	Kicked in abdomen during a fight	12 hr. preop.	Possible ruptured urinary bladder	Elevation of right diaphragm, peritoneal irritation noted
8	45	M	Struck by auto while intoxicated, hematemesis present	24 hr. (?) preop.	Indefinite intra-adominal injury	No free air under the diaphragm
9	15	M	Patient riding bicycle, hit an auto thus driving handle bars into abdomen, hematemesis present	8 hr. preop.	Perforation of hollow viscus	Free air under both halves of diaphragm
10	66	M	Struck by an auto	18 hr. preop.	Perforated abdominal viscus	No free air, fractured pelvis
11	33	F	Kicked in abdomen during a fight	24 hr. preop.	Perforated abdominal viscus	Minimal free air under right diaphragm
12	14	F	Struck in abdomen by handle bars of bicycle while riding, unconsciousness and hematemesis present	5-7 hr. preop.	Perforated abdominal viscus	No free air
13	53	M	Slipped on tile floor falling on abdomen, no vomiting	12 hr. preop.	Perforated abdominal viscus	No free air
14	50 (?)	M	Struck by hit and run driver, unconsciousness, projectile vomiting	Not known	Intracranial injury and shock	Skull fracture

OPERATIVE FINDINGS	PERITONITIS	ASSOCIATED PATHOLOGY	FINAL OUTCOME	AUTOPSY REVELATIONS
Moderate amount of intestinal fluid, 1½ inch perforation in ileum 18 in. from ileocecal junction	General	Lacerations of scalp	Developed delirium tremens 2 postop., died 5 postop. day	Generalized peritonitis
No operation	General	Fractured ribs and bronchopneumonia	Expired 36 hr. after admiss.	Genl. peritonitis. Two small perforations in ileum 2 ft. from ileocecal valve
Small amount bile-stained fluid in peritoneal cavity, ¼ inch perforation in first portion of duodenum	General	Scalp laceration, fracture nasal bones and humerus, laceration abdominal wall	Expired 4th postoperative day	Generalized peritonitis
No operation	General	Fractured pelvis	Died 7 hr. after injury	3 small perforations in ileum 2 ft. from ileocecal valve, genl. peritonitis
Moderate amount of intestinal fluid, ½ in. laceration ileum 2 ft. from ileocecal junction	General	Multiple abrasions, periorbital ecchymosis	Died 8 hr. after operation	Generalized peritonitis
Contusion of pylorous and duodenum, localized peritonitis suggesting a walled-off perforation not seen	Local	Multiple contusions and retroperitoneal hemorrhage	Died 13th P.O. day	Walled off ¼ in. perforation on post. wall of duodenum, blood from tear in superior pancreaticoduodenal artery
50 c.c. intestinal fluid aspirated, 4 in. laceration in omentum, 2 ft. from ligament Treitz ½ circumference of jejunum torn	General	Ecchymosis of abdominal wall and above pubis, prevesical hematoma	Developed cystitis and wound infection. Discharged 43 days P.O.	
250 c.c. serosanguineous fluid, 1½ ft. from ligament Treitz a 1¾ in. rent in jejunum involving ¾ circumference, mesenteric hematoma	General	Multiple contusions, laceration of scalp	Died 4 days after operation	Generalized peritonitis
500 c.c. intestinal fluid with partially digested food, 1 ft. from lig. Treitz a rent involving ½ circumference of the jejunum.	Local	Multiple contusions and abrasions	Developed bronchopn. Discharge 22 days P.O.	
300 c.c. of purulent serosanguineous fluid, a ½ in. laceration found 2 ft. from ileocecal valve	General	Shock, fractured pelvis, lacerations of face	Expired on first P.O. day	Generalized peritonitis
300 c.c. bile-stained fluid, 4 in. from ligament Treitz a ¾ in. laceration found in jejunum	Local	None	Discharged 19 19 days P.O.	
50 c.c. of turbid bile fluid, 10 in. from ligament of Treitz ½ in. laceration found in jejunum	Local	None	Discharged 15 days P.O.	
100 c.c. straw-colored fluid with flakes of fibrin, 3 ft. from ileocecal valve a ½ in. laceration found in ileum	Local	None	Developed wound infection, discharged 46 days P.O.	
	General	Shock, fracture of skull with brain laceration	Died 29 days after admission	½ in. laceration in ileum 2 ft. from ileocecal valve, general peritonitis

producing a tear. The other most frequent location for traumatic laceration is within two to three feet proximal to the ileocecal valve. These lesions result when the external force compresses the ileum against the vertebral column or the pelvic bones. Another contributing factor may be the increase in intra-abdominal pressure from external violence. How much the sudden compression of fluid or gas within an intestinal loop contributes to the etiology of this injury is purely speculative.

A study of traumatic perforations of the small intestine at Kings County Hospital is the subject of this communication. From January, 1934, to June, 1943, only eighteen authentic cases, proved by operation or at autopsy, were encountered. Fourteen of these cases will be presented in composite form. The remaining four, which came under our personal care, will be presented in detail.

CASE REPORTS

CASE 15.—The patient was a 6-year-old colored boy who was brought to the hospital by our ambulance on April 24, 1943. He was found lying in the street after having been struck by a trolley car. There was no history of unconsciousness. An hour following the accident, the patient complained of abdominal pain, was very restless, and vomited twice. The vomitus was gastric contents, no blood in the vomitus recorded.

Examination on admission revealed a fairly well-developed, poorly nourished, apathetic Negro boy. His pulse was 104, temperature 101° F., and respirations 22. The significant findings were confined to the abdomen. Diffuse rigidity with marked tenderness was present in the left upper quadrant. Auscultation revealed absent peristalsis.

Blood studies demonstrated a red count of 4,350,000. An hour later the count fell to 3,500,000. The white cells amounted to 11,000 with 89 polymorphonuclears. A preoperative x-ray of the abdomen showed small bowel distention, but failed to indicate a pneumoperitoneum.

A delay in operation occurred due to the refusal of the legal guardian to consent to operation. The child was observed. The record revealed a gradually falling blood pressure associated with a slow rising pulse. Seven hours after the injury the patient was taken to the operating room.

Under general anesthesia, through a midline upper abdominal incision, an exploratory laparotomy was performed. No free fluid was found in the peritoneal cavity. Six inches from the ligament of Treitz a laceration on the antimesenteric border of the jejunum was found. This rent was one inch in length. An inflammatory plastic exudate surrounded this area of perforation. This laceration was repaired in the usual manner, and the abdomen closed in layers. The patient was given a blood transfusion during and following this procedure. The child had an uneventful recovery and was discharged on May 11, 1943.

CASE 16.—This is the case history of a 45-year-old white man who was struck by an automobile on the night of June 19, 1943. Following this accident the patient was unconscious. More detailed information could not be obtained.

Physical examination on admission demonstrated the following positive findings. The temperature was 97° F., the pulse 100, respirations 18, and the blood pressure 100/70. A strong alcoholic odor to the breath was present. The patient was unconscious with only slight response to noxious stimuli. Dried blood was present in

both nares and in both external auditory meatuses. Multiple abrasions were noted. The blood mentioned apparently arose from a laceration of the face. Mild to moderate spasm of the abdominal muscles in the upper abdomen was the only abdominal finding of note.

Four hours after admission the patient regained consciousness and complained of abdominal pain. Abdominal rigidity was now generalized with marked tenderness in both lower quadrants. Shortly after this he vomited a moderate amount of dark black material resembling old blood. At this time his blood pressure was 70/40, the pulse was 130, rapid, and thready. Catheterization emptied the bladder of six ounces of clear urine.

The patient was given a blood transfusion, treated for shock, and transferred to the surgical service. Seventeen hours after admission an exploratory operation was performed with a preoperative diagnosis of a perforated abdominal viscus.

A preoperative roentgenogram of the abdomen showed distended loops of small intestine. No evidence of free air under the diaphragm could be demonstrated in this or other roentgenograms.

At operation the peritoneal cavity was found to contain a large amount of slightly cloudy, blood-tinged fluid. Loops of ileum in both lower quadrants were covered with a thin plastic exudate. Two feet proximal to the ileocecal valve, three perforations were found on the antimesenteric border of the ileum. The largest was one inch in length, the smallest one-fourth inch, and the other one-half inch. The usual type of repair was accomplished. Closure of the abdominal incision was in layers with catgut and black silk for the skin.

On the sixth postoperative day the patient developed delirium tremens. He subsequently had a wound infection, but finally left the hospital on the forty-third postoperative day.

CASE 17.—This is the history of a 59-year-old white peddler who was kicked in the abdomen several times during the course of an attempted robbery. He did not lose consciousness while he was being assaulted. He was taken to another hospital, about 10:00 P.M. on a Saturday night. Here both his chest and abdomen were x-rayed and reported to be negative. At this time a diagnostic paracentesis abdominis in all four quadrants was carried out. This likewise failed to reveal any positive information. After this treatment the patient signed his release from the hospital and went to his home which was in another section of the city. While at home he had moderately severe pain throughout the abdomen associated with constipation. His family physician was called and advised hospitalization. About this time he vomited on two different occasions. There was no blood in the vomitus. He finally entered Kings County Hospital at 3:30 A.M. on Sunday morning (May, 1943). Physical examination revealed the patient as being in moderate distress due to abdominal pain. The temperature was 99° F., the pulse 84, respirations 18, and the blood pressure 100/60. The significant physical findings were confined to the abdomen. Respiratory excursions were limited in the lower half of the abdomen associated with lower abdominal distention. Moderate tenderness was elicited in the right lower quadrant without rebound. Slight rigidity was found in both lower quadrants. There was no obliteration of liver dullness. Peristalsis was not audible. There was no clinical evidence of free fluid in the peritoneal cavity. A reducible right indirect hernia was noted. Rectal examination demonstrated nothing of note.

Flat plate x-ray of the abdomen showed obliteration of the lateral abdominal muscle wall shadow indicating the presence of fluid within the peritoneal cavity. Distention of the small bowel was demonstrated, which was consistent with an adynamic ileus as seen in peritonitis. No free air was visualized under the diaphragm.

The patient was given a blood transfusion and subjected to an exploratory operation four hours after admission. When the peritoneal cavity was entered a moderate amount of cloudy fluid was encountered. Several loops of ileum in the right lower quadrant were adherent to each other by means of a fibrinous plastic exudate. Two perforations in the ileum were discovered, one-fourth and one-half inch in diameter, respectively. The first was one and one-half feet proximal to the ileocecal junction, the other six inches proximal to the first perforation. These perforations were repaired in the usual fashion and the abdomen closed in the routine manner.

The postoperative course was complicated by a grossly infected wound which necessitated secondary closure. The patient was allowed out of bed on the twenty-fifth postoperative day and discharged forty-seven days after operation.

Fig. 1.—Free air is clearly visible under the diaphragm indicating a perforation of a hollow viscus (Case 18).

CASE 18.—A 45-year-old white man arrived at the hospital at 2 A.M. on June 17, 1943. He complained of pain in the lower abdomen associated with difficulty of urination. All these complaints were of two weeks' duration. In addition he had a productive cough for the same two weeks. The day before admission was the worst day of the entire two-week period. The pain became unbearable and the urinary difficulty increased in intensity. Upon questioning by a member of the house staff the patient said that his pain was first generalized, then localized to the right

lower quadrant; vomiting followed the onset of his first bout of pain. An important bit of information was obtained by the second examiner. The patient informed him that two days before entering the hospital, he struck his abdomen against the side of his bed while attempting to go to the bathroom. As he was getting out of bed, he felt very weak, seemed to faint, fell and struck his right side while falling. Since his fall the abdominal pain has become progressively worse. This pain prompted him to enter the hospital.

Examination on admission showed that the temperature was 103.2° F., respirations 32, pulse 122, and blood pressure 110/60. The significant findings were abdominal. The abdomen was rotund, moved sluggishly with respirations. Right rectus rigidity with right lower quadrant tenderness and rebound were prominent. Peristalsis was markedly diminished on auscultation. A positive Bastedo sign was elicited. Rectal examination demonstrated a fullness in the right pelvis which was tender on compression. The prostate was slightly enlarged.
It was thought that the patient had generalized peritonitis due to a perforated peptic ulcer, or due to a gangrenous perforated appendix.

A flat plate of the abdomen and an x-ray of the chest were ordered at that time. The roentgenogram of the abdomen indicated peritonitis. In addition, free air was clearly visible under the diaphragm.

Conservative therapy was instituted. This consisted of intravenous fluids, chemotherapy, blood transfusion, Fowler's position, and sedation as needed.

Four hours later the following note was made. The white blood count had risen from 8,950 with 92 per cent polymorphonuclears to 13,100 with 95 per cent polymorphonuclears. Abdominal signs became more localized to the right iliac region. Obliteration of liver dullness with x-ray evidence of air under the diaphragm indicates a perforation of a hollow viscus. An immediate operation was advised.

An exploratory operation was performed twelve hours after admission. A laceration on the antimesenteric border of the ileum one inch in length was found two feet from the ileocecal valve. Generalized peritonitis was present. The perforated area was adherent to the appendix. It appeared that the appendix was making an ineffectual attempt at walling off the perforation. The appendix itself was surrounded with a dense plastic exudate. Two collections of purulent exudate were found in the pelvis. The perforation was sutured and the abdomen closed after the usual deposition of sulfanilamide into the peritoneal cavity. The prognosis was very unfavorable and the question presented itself as to the advisability of the operation.

Postoperatively the temperature was septic in type rising to 102 and 104° F. The pulse was rapid, thready and of poor quality. On the second postoperative day the patient expired. No autopsy was obtained.

DISCUSSION

An analytic study of these eighteen cases brought to light many salient factors of importance. These will be discussed individually. In view of the fact that the number of our cases is limited, it was thought best not to interpret our findings in terms of percentage, but rather to concern ourselves with certain general principles derived from our survey.

The most important single contribution made by the patient, which aids us in arriving at a diagnosis of intestinal perforation, is the history of trauma followed by abdominal pain. Either continuous or intermittent pain which is persistent, associated with vomiting or hematemesis, may indicate visceral injury. Hematemesis is especially prominent in perforations of the duodenum. In our series, five out of seven patients

with rupture of the duodenum or of the jejunum near the ligament of Treitz gave a history of bloody vomitus. The surgeon should not be deceived by a post-traumatic period of freedom from symptoms. A history is possible in which the patient with an intestinal perforation has walked and showed no signs of an abdominal calamity only to seek medical assistance hours following injury.

Examination of the patient in most cases suggests the presence of an acute surgical abdomen. Where a decision cannot be reached as to operability, frequent repeated physical examinations are important. The pulse and blood pressure should be recorded hourly. A steadily rising pulse rate, after the initial shock of injury has subsided, is especially significant. Often a varying picture may be present without any definite physical signs. The patient may eventually enter the hospital for an associated minor injury or because the first noted symptoms were those complicating the injury (most often peritonitis). The evidence of shock may show itself many hours after the injury. This may be due to the leakage of intestinal contents into the peritoneal cavity following an initial walling off of the perforation. Symptoms and signs of peritonitis are present when this state exists.

The diagnosis clinically categorizes these cases into three groups:

1. Those patients with severe multiple injuries which are inevitably fatal
2. Cases that demand immediate surgical intervention
3. Situations in which the diagnosis is doubtful and the indications for and against operation are not definitely established

In the care of this last group the mortality may rise or fall. If there is one sign or symptom pointing to the possibility of a perforated viscus, and the patient is a satisfactory risk, surgery should be undertaken.

An accurate diagnosis may be reached occasionally by means of a flat plate x-ray of the abdomen. These radiographs should be taken in the sitting position or standing when possible. Thus, the free gas in the peritoneal cavity can ascend and is more easily recognized by its concentration beneath the diaphragm. A crescent of sickle-shaped gas accumulation over the liver and beneath the diaphragm can be seen in positive cases. Gas when present is certain evidence of intestinal perforation. If it is absent or unrecognized it does not rule out this possibility. An accurate evaluation of our cases in this regard could not be made since this procedure was omitted in several instances. We have noted, however, that free air under the diaphragm was seen more frequently in perforations of the upper small bowel, especially when the duodenum was involved. This is due to the fact that the stomach contains much air. Thus, when a perforation occurs in its vicinity this air is liberated. Perforations near the ileocecal valve have a tendency to

be walled off by loops of intestine or omentum and infrequently yield sufficient air to be demonstrated under the diaphragm. Moreover, these lower segments do not contain much air. In some cases a paralytic ileus from the injury may be seen by x-ray. This is due to inhibition of peristalsis. The ileus allows a plastic exudate to cover the perforation. Following the ingestion of food, peristalsis commences again. This movement breaks the exudate about the perforation and air may be eliminated and visualized by roentgenogram.

When the diagnosis of small bowel perforation has been made, surgery is contemplated. The preoperative treatment for shock and dehydration is of paramount importance when indicated. Whenever possible, the choice of the anesthetic should be made by the anesthetist. In almost all of our cases general anesthesia was employed.

At operation a right rectus incision was favored. This incision could be extended inferiorly or superiorly as the need arose. Upon opening the peritoneal cavity the type of fluid encountered hinted at the location of the perforation. Perforations in the lower segments of small bowel expel much fluid into the peritoneal cavity. The fluid is typical of small intestinal contents. In lesions of the upper segments little or no fluid is found. Especially is this true if the trauma occurs after the stomach has been emptied. When fluid is encountered it is similar to that seen in perforated peptic ulcers. Duodenal rents may be associated with bile-stained fluid. Retroperitoneal hemorrhage was encountered in one case due to a tearing of the superior pancreaticoduodenal artery.

Identification of the type of fluid in the peritoneal cavity facilitated the exploration of the intestinal tract. When little or no fluid was found, examination of the small intestine commenced at the duodenum and was traced distally. A large amount of fluid indicated that primary exploration should commence at the ileocecal valve and be traced proximally. The perforations in the terminal ileum usually occurred within two to three feet from the ileocecal junction. In this area many cases revealed the perforations to be multiple (two or three). This was contrasted with single lacerations as found in the duodenum or near the ligament of Treitz. In the majority of our cases the lacerations were located on the antimesenteric border and had a tendency to be transverse in direction. When generalized peritonitis was found, the exploratory procedure as described could not be followed satisfactorily.

In some of these cases a prognostic sign was observed beneath the parietal peritoneum. It is known anatomically that the attached surface of the peritoneum is rough, being connected to the inner surface of the parietes by means of areolar tissue termed the subserous areolar tissue. This areolar tissue is covered by a layer of flattened mesothelium which gives the peritoneum its smooth transparent glistening appearance. It has been noted in cases of peritonitis that this mesothelial surface

retains its normal characteristics. However, the subserous areolar tissue alters its appearance. The color becomes a muddy grayish green, due perhaps to extensive and intensive absorption of toxins from the peritoneal cavity. This discoloration is seen where the peritoneum is most closely adherent—as in the middle line of the abdomen. In all cases where this discoloration was observed the outcome was death. This observation has been recorded in cases other than those discussed in this series. At autopsy the discoloration cannot be demonstrated since the peritoneum shows postmortem change and other alterations compatible with peritonitis.

Following the surgical repair of the traumatic perforations, in this series, chemotherapy was employed routinely since the adoption of this therapy for intraperitoneal use. Sulfanilamide, 5 to 10 Gm., and in some instances mixtures of sulfanilamide and sulfathiazole were employed. It is felt that the eventual outcome was not influenced by this therapy.

Of the eighteen cases presented, only eight patients survived. Thus, it can be appreciated how high the mortality is in this type of abdominal trauma. A contributing cause is the multiple injuries. Where severe multiple injuries are present, in addition to the small bowel rents, the outcome is usually death. In the majority of our cases the perforations in the small intestine were the most outstanding injury and with its complicating peritonitis, was the cause of death. In our mortality of ten patients, seven of these had complicating injuries or illnesses. The lowering of this high mortality resides with the surgeon. A decision for or against operation in traumatic abdominal injuries should be made as soon as possible. Ideally, four to six hours after the accident is the most favorable time. Delay, lingering, and waiting are the most common reasons for a fatal outcome. The longer the delay, the more unfavorable is the prognosis. This delay may be due to the patient's failure to seek early medical care. Occasionally the delay is caused by the surgeon who fails to evaluate the serious nature of the injury.

SUMMARY

1. Injuries to the small intestine caused by nonpenetrating trauma constitute one of the most lethal conditions encountered in abdominal surgery.

2. Eighteen cases of this type, without evidence of severe injury to the abdominal wall, are presented for critical study.

3. The importance of the history is stressed. This should exclude the possibility of previous abdominal disease, and notation should be made of the time passed since eating or drinking.

4. In the physical findings a progressively rising pulse rate and a change from local to generalized abdominal tenderness with rigidity are indicators for surgical intervention.

5. Roentgenograms of the abdomen are valuable aids in the diagnosis when air is present under the diaphragm. When gas is not visualized

it does not exclude the possibility of perforation of a hollow viscus. Positive x-ray findings are more common in perforations of the upper small bowel than in the lower segments.

6. Leucocytosis may or may not be present.

7. At operation the character of the free fluid in the peritoneal cavity suggests the location of the traumatic pathology.

8. The most frequent sites of rupture are: within two to three feet from the ileocecal junction, the duodenum, and near the ligament of Treitz. Perforations of the ileum often are multiple. Those in the duodenum and the vicinity of the ligament of Treitz are usually solitary.

9. An analysis of these cases demonstrates that an individual of any age may suffer an intestinal perforation. There was a predominance of white male patients in this series.

10. The mortality in visceral trauma is unusually high. Ten of our eighteen patients succumbed to their injuries. The excessive mortality is due in part to multiple injuries. A decrease in mortality rate depends upon improved diagnosis, plus the appropriate time for surgical interference.

CONCLUSION

The purpose of this communication was to present the studied results of a surgical problem associated with a high mortality. This problem concerns injuries to the small intestine produced by nonpenetrating forces to the abdomen, however slight they may be. Clinical experience warrants the belief that the unfortunate outcome in many instances, although easily understood, can be prevented, since the surgical repair in almost all cases is not difficult.

Early diagnosis and immediate treatment are the measures necessary for adequate solution to the problem. Perforation of the small intestine is a potential injury following any abdominal trauma. A patient who has sustained an unexpected blow, or other trauma, to the abdomen should be held in suspicion as a candidate for a small bowel rent.

Successful treatment to obtain eventual recovery is dependent upon:

1. Immediate recognition that an intra-abdominal perforation exists.
2. A decision that an operation is necessary provided the patient is a satisfactory operative risk.
3. The least possible delay plus the most rapid method of operative repair. This will tend to decrease what seems to be an unusually high mortality. This mortality is attributed to peritonitis resulting from delayed operation.

It is hoped that this survey has contributed in some way toward facilitating the diagnosis of small bowel perforation. When this diagnosis has been reached, an exploratory laparotomy is imperative. Surgical intervention offers the only hope of recovery in perforations of the small intestine.

SPINAL ANESTHESIA

A Study of Safety Factors and Postoperative Pulmonary Complication in 1,344 Consecutive General Surgical Procedures on Naval Recruits

E. Dean Babbage, Lieutenant Commander, Medical Corps, U.S.N.R. and Charles W. McLaughlin, Jr., Lieutenant Commander, Medical Corps, U.S.N.R.

SAFETY factors in any anesthetic agent have always been of paramount interest to anesthesiologists and surgeons. This is especially true when anesthesia is induced by the spinal method.

We wish to report our results at the McIntire Dispensary, U. S. Naval Training Station, Great Lakes, Ill., in a group of 1,344 young men admitted to this institution for corrective surgical procedures during a six and one-half month period from Jan. 1 to July 15, 1943. The majority of these recruits were between the ages of 17 and 24 years, the oldest being 39 and the youngest 15. Most of the surgical procedures were of a rehabilitory nature in men entering the service with inguinal hernia, hydrocele, varicocele, or ventral hernia. The remainder of the procedures were for injures or acute inflammatory diseases the men contracted during their boot training, such as appendicitis, hemorrhoids, and fractures.

This training station draws its recruits from a large area of the United States, extending into the Eastern seaboard, the deep South, and the Pacific Coast. Many of these men have never seen ice or snow and travel here during the winter months in clothing which is quite inadequate. A majority of the recruits arrive at the station after sitting up for twenty-four hours or longer in railway coaches and are suddenly introduced to a vigorous northern climate. Within twenty-four hours they proceed through the recruit examination line. In this period of examination at least two hours are required during which time the men are without clothing. Those requiring surgical attention are withdrawn from this line and transferred for hospitalization. As a consequence of this intimate exposure of men from different localities, respiratory infection is rampant, especially during the winter and spring months.

In February, 1943, we established a surgical preoperative ward in an effort to screen all surgical patients with respiratory infection. All preoperative cases of an elective nature were admitted to this ward which is under the direction of one of the surgical staff. Histories and physical examinations were done on the ward, routine blood studies and a urinalysis obtained, and the temperatures were recorded every four

Received for publication, Aug. 23, 1943.

hours. No man was subjected to a major surgical procedure until he had been observed in the ward for three days, during which time he must have maintained a normal temperature before becoming eligible for surgery. Likewise, no one was operated upon by an elective procedure who demonstrated a very red throat. As an added precaution, the candidates for surgery were inspected carefully the morning they were scheduled for operation. During the six and one-half month period, 173 cases in which the patients were considered satisfactory for operation were canceled on the day they were listed for surgery because of a slight degree of fever, the development of a sore throat, or other symptoms of a mild upper respiratory infection. We are convinced that this careful preoperative study and observation period has paid dividends in lowering our incidence of postoperative respiratory complications.

It is suggested that this report of our results with spinal anesthesia, using different agents, may be of assistance to the surgeon who has not had the good fortune to have available the services of an experienced anesthesiologist. This situation will occur many times during the remainder of the war, especially aboard ship and at small isolated shore stations. When a surgeon, unskilled in the use of anesthetic agents for intraspinal use, is called upon to give a spinal anesthetic, he immediately asks himself several questions:

What agent shall be employed?
What dosage shall be given?
What interspace shall be used?
What shall be the volume of the solution injected?
How shall the operating table be tilted, i.e., head up, flat, or head down?
What if the anesthetic goes too high?
What if the anesthetic is a total failure?

Nowhere can the answer to all these questions be found in any one textbook or any recent article in the literature which is readily available. The Navy has answered one question concerning the agent to be used, since the only preparation on the supply table is procaine hydrochloride. Any other agent must be especially requisitioned.

In this dispensary the surgical procedures were performed by four surgeons. The anesthetics were given or supervised by one of us and an established routine was employed. All patients were given a preoperative hypodermic or morphine sulfate, gr. $\frac{1}{4}$, and atropine sulfate, gr. $\frac{1}{150}$. This was administered approximately one hour before the scheduled time for operation. Just before the lumbar puncture was done, one-half of a syrette of ephedrine (37 mg.) was given. The remainder was kept sterile for use later in the operation if necessary or for another patient.

The spinal puncture was made in the third or fourth lumbar interspace, with the patient lying on his side, using a 20 gauge needle with a sharp point. Either 150 mg. of procaine or 150 mg. of metycaine were used. The patient was immediately placed on his back following the injection. The table was left flat in all cases, unless the height of anesthesia was inadequate. In this latter case the head of the table was lowered until anesthesia was sufficiently high or the conclusion reached that the anesthetic was unsatisfactory.

This procedure was used in all cases submitting to herniorrhaphy, appendectomy, or operations on the genitals with satisfactory anesthesia persisting for approximately one hour. For hemorrhoids or circumcision, 50 mg. of either metycaine or procaine were employed. For anything above the umbilicus, such as an epigastric hernia or cholecystectomy, and for any procedure where we contemplated more than one hour might be used for the operation, 10 mg. of pontocaine mixed with 100 mg. of procaine were used. This will not be discussed further except to say we have used it fifty-three times in this series with satisfactory results. This combination has been found by one of us (E. D. B.) to be a perfectly safe and reliable anesthetic agent for a single-dose technique, usually giving adequate anesthesia for at least ninety minutes. In general, it is desirable to consider every case submitted to surgery as an individual anesthetic problem, but our experience leads us to believe that this routine as outlined can be safely followed with satisfactory results.

Special anesthetic charts were maintained in a consecutive series of 945 patients operated upon under spinal anesthesia. From Feb. 10 to March 19, 1943, 150 mg. of metycaine were used as the anesthetic agent, being diluted to 4 c.c. with spinal fluid. A series of 259 cases was included in this group. Three inadequate anesthesias resulted, and these were supplemented with local infiltration or pentothal sodium intravenously. Seven patients in this series of 259 developed total sensory anesthesia during the operative procedure. In none of these seven cases could the patients move their arms, nor was pain elicited when traction was made on the hair of their head. Two of them required artificial respiration for about ten minutes. There were no sequelae from this high anesthesia in any instance.

From March 20 to June 1, the anesthetic agent used was 150 mg. of procaine crystals dissolved in 4 c.c. of spinal fluid. There were 337 cases in this series. In none of these cases did the anesthesia extend sufficiently high to produce any respiratory distress. A very few patients experienced slight transient numbness in their fingers but no motor paralysis of the arms was evident. Nine inadequate anesthesias resulted and these were supplemented with local infiltration or intravenous sodium pentothal.

From June 1 to July 1, 1943, metycaine was again employed as the anesthetic agent, using 100 mg. dissolved in 3 c.c. of spinal fluid. In

this series of 164 cases, one unsatisfactory anesthesia was observed, twelve patients developed nausea on the table, and total sensory anesthesia developed on three occasions. This high incidence of total sensory anesthesia confirmed our experience with this agent noted in the previous group of cases.

From July 1 to July 15, 1943, the anesthetic agent employed was again procaine, there being 113 cases in this group. Five of these patients developed nausea and one case of inadequate anesthesia occurred. It is interesting to note that in this latter series, we observed the only case of total sensory anesthesia seen when procaine was the anesthetizing agent. Respiratory paralysis did not develop, the patient responding promptly to inhalations of oxygen. No sequelae developed.

Careful analysis of the blood pressure curves in this series of patients fails to reveal any marked difference in the fall of blood pressure with the two agents used. It seldom occurred that the pressure dropped below 100 mm. of mercury, and in no case was a blood pressure observed that fell below 80. This is to be expected since we were dealing entirely with physically robust young adult men.

In discussing the obvious safety of procaine over that of metycaine, several factors should be taken into consideration. Metycaine in our hands has resulted in fewer anesthetic failures, but we believe its use is more hazardous unless one has at hand means for giving artificial respiration and one skilled in its use. While in any well-organized hospital such means are available, they may not always be present under wartime conditions. Granted, there are more failures of anesthesia with procaine, but in the dosage we have used, and given by the technique outlined here, it is a safer anesthetic for the surgeon to employ for lower abdominal procedures. It is so rare that sensitivity to this dosage of procaine results, that this factor may practically be ignored. In explanation of the higher percentage of failures with procaine, it has been shown since the use of continuous spinal anesthesia by the Lemmon technique that most patients will tolerate large amounts of procaine and that some individuals will require two or three times the dosage we have routinely used in this series before anesthesia develops. One of us (E. D. B.) has observed patients who required 400 mg. of procaine before anesthesia was established and has used as high as 900 mg. in one patient over a period of three hours with no untoward results. One may conclude from this that should a spinal anesthetic with procaine prove to be a total failure, a logical and safe procedure would be to repeat the spinal puncture, giving a second smaller dose of procaine.

There has been less nausea with procaine hydrochloride than with metycaine (Table I). Fifty-one patients out of 519 were nauseated when procaine was the anesthetizing agent, an incidence of 9.8 per cent, while fifty-five cases out of 426 developed nausea on the table when metycaine was used, an incidence of 12.9 per cent.

TABLE I

SPINAL ANESTHESIA; A COMPARATIVE STUDY OF 945 CONSECUTIVE CASES USING TWO DIFFERENT ANESTHETIC AGENTS

AGENT	TOTAL NO. CASES	NO. CASES INADEQUATE ANESTHESIA	NO. PATIENTS NAUSEATED	NO. CASES HIGH ANESTHESIA	% CASES INADEQUATE	% PATIENTS NAUSEATED
Procaine	519	10	51	1	1.92	9.8
Metycaine	426	4	55	10	.94	12.9

The following measures were employed for reduction of the incidence of postoperative pulmonary complications. All patients were required to breathe a mixture of 10 per cent CO_2 and 90 per cent O_2 for two minutes after completion of their operation and before leaving the operating room. The patient was instructed that he should cough at will if he had any desire to do so. He was shown how to hold his abdomen with both hands when coughing, pressure being exerted not over the incision, but between his umbilicus and costal margins. This is a very important point and gives the patient marked relief from pain when coughing is necessary. After the return of the patient to the ward, the corpsmen were instructed to turn each patient every two hours from side to back and back to side. All patients were given a five-pound paper bag to breathe into while it was firmly held over the mouth and nose. This was done for two or three minutes every two hours the first three postoperative days. Cough mixtures with codeine were not permitted, but expectorant drugs without opiates were employed.

It has been a revelation to us how little morphine was required during the postoperative period to keep these patients comfortable. Morphine was given when necessary for the patient's comfort and no effort was made to limit its use when indicated. The average was less than two hypodermics for each postoperative patient since they simply did not seem to require its more frequent use.

We have stimulated a great interest among corpsmen in postoperative pulmonary atelectasis, and they have been taught to recognize its early signs and symptoms. A sudden postoperative rise in temperature, pulse, and respiratory rate, lagging of the involved chest, and cough, which may be nonproductive, is the usual picture. The early physical findings may be very minimal other than a decreased respiratory excursion and in our experience a mediastinal shift to the involved side is only an accompaniment of a lobar or massive collapse. When a patient does develop atelectasis, the mixture of 10 per cent CO_2 and 90 per cent O_2 is given for at least two minutes every hour, the patient even being wakened for this treatment during the night, until the lung is again re-expanded. In addition, all of these patients are cared for by a special watch who is instructed to turn them from side to side every hour, insist upon deep breathing exercises, and encourage cough-

ing until the obstructing secretion is expectorated. We routinely take bedside x-rays of all such chests, but in many of those with lobular collapse the condition had cleared before the film was taken. The reason for this is that the corpsmen are constantly on the alert for lung complications and begin CO_2 and O_2 inhalations as soon as they notify the ward physician that something appears to be wrong with a patient's breathing. We have observed a total of nineteen cases of atelectasis in this series of 1,344 cases, nine being lobar in type and ten lobular in extent (Table II). No case of atelectasis has required bronchoscopic drainage for re-expansion of the lung.

TABLE II

POSTOPERATIVE PULMONARY COMPLICATIONS IN A SERIES OF 1,344 GENERAL SURGICAL PROCEDURES WITH SPINAL ANESTHESIA ON NAVAL RECRUITS

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	TOTAL
Tracheobronchitis	1	4	1	1	0	0	0	7
Atelectasis	2	6	5	0	2	2	2	19
Pneumonia	2	2	0	0	0	0	0	4
Acute catarrhal fever	1	3	2	0	0	0	0	6
Acute tonsillitis	0	2	0	2	1	0	0	5
Total cases pulmonary complications	6	17	8	3	3	2	2	41
Total number major cases	247	244	223	151	141	225	113	1344
Surgical mortality	0	1	0	0	0	0	0	1
Cases canceled A.M. of operation—rise of temperature or acute throat	20	60	34	17	20	12	10	173
Per cent incidence postoperative pulmonary complications	2.4	4.9	2.7	2.0	2.1	.9	1.7	3.1

We have had one death in this series of patients developing atelectasis. However, this individual had a septicemia with metastatic peritonitis and at post mortem the atelectatic area had cleared and was not a factor in the fatal issue.

One of us (C. W. M.) in a previous review of the literature analyzed a series of 22,962 surgical procedures and found the incidence of postoperative pulmonary complications to be 1.38 per cent. In our experience at McIntire Dispensary, 41 patients have developed postoperative pulmonary complications in a series of 1,344 surgical procedures, an incidence of 3.1 per cent. We must admit that this is slightly higher than the average throughout the country but we believe, considering the fact that we are subjecting men who are not native to this locality to surgical procedures, our statistics are what must be expected. We further believe that if these procedures were not carried out, our incidence of postoperative pulmonary complications would have been much higher.

It is of interest to note that all patients in this series received spinal anesthesia. It is a popular but erroneous belief among surgeons that when this anesthetic is used, the danger of postoperative pulmonary complications is lessened,

SUMMARY AND CONCLUSIONS

1. A series of 1,344 young naval recruits subjected to corrective general surgical procedures under spinal anesthesia are reported.

2. A technique for the administration and control of the spinal anesthetic is outlined and the results with two different anesthetic agents in a consecutive series of 945 cases are presented.

3. A higher percentage of anesthetic failures may be expected when procaine hydrochloride is the agent employed, but this appears to be offset by the greater safety of this drug.

4. Postoperative pulmonary complications were observed in 41 patients in this series of 1,344 cases, an incidence of 3.1 per cent.

5. The routine use of spinal anesthesia does not result in a lowered incidence of postoperative pulmonary complications.

REFERENCES

1. Eliason, E. L., and McLaughlin, C. W., Jr.: Post-Operative Pulmonary Complications, Surg., Gynec. & Obst. **55**: 716-727, 1932.
2. Eliason, E. L., and McLaughlin, C. W., Jr.: Post-Operative Pulmonary Atelectasis, S. Clin. North America **14**: 1-13, 1934.

SENSITIVITY TO LOCAL APPLICATION OF SULFANILAMIDE*

LIEUTENANT COMMANDER LEON J. TAUBENHAUS,
MEDICAL CORPS, U. S. N. R.

SENSITIVITY to sulfanilamide is not rare, and cutaneous manifestations are well known. However, a widespread cutaneous reaction to the continued local application of sulfanilamide powder over a small wound is certainly worth noting.

CASE REPORTS†

CASE 1.—A 21-year-old Marine was injured in a jeep accident, May 18, 1942. At that time he received two deep abrasions of the left forearm just below the elbow. He was treated by topical applications of sulfapyridine ointment until June 7, 1942, when he came under my care. At this time he had two necrotic ulcers, each about one inch in diameter, occurring about one inch medial to and below the left antecubital space.

Treatment during the next three weeks consisted of daily dusting the wounds with sulfanilamide powder. He showed gradual improvement. The discharge became minimal and the base of the ulcers took on a clean, granulating appearance. The wounds did not decrease in size.

On June 23, 1942, sixteen days after receiving this treatment, he developed what seemed to be a mild sunburn on both shoulders. He was advised to keep out of the sun and sulfanilamide dustings of the wounds were continued.

The next day he reported to the sick bay with a diffuse, bilateral, vesicular rash which was present on both shoulders, arms, forearms, hands, fingers, and palms. The rash was roughly symmetrical on both upper extremities, more marked on the volar surfaces, and most marked in the left antecubital space and around the site of the original wounds. The fingers were swollen and painful, but the rash itself was not painful. Sulfanilamide applications were discontinued and boric acid dressings applied.

On June 27, 1942, three days later, the rash had practically disappeared and epithelial regeneration was noted around the edges of the original wounds, but there was a profuse discharge of pus from the wounds.

On July 2, 1942, sulfanilamide powder was again applied to the wounds, and by the next morning the rash had recurred, identical with its previous appearance. In addition, the patient complained of a dull headache and vague chest pains. Facilities for a laboratory study of the case were not available. By July 5, 1942, two days after the sulfanilamide dustings were again discontinued, the rash had again practically disappeared and the ulcers were epithelizing satisfactorily. On this date the patient was transferred elsewhere feeling quite well.

CASE 2.—A Marine received a bullet wound of the calf of the leg during combat in October, 1942. He was treated by daily applications of sulfanilamide powder into the wound, and because of the minor nature of the wound, he was kept on duty. By the middle of November, about one month later, the wound had not improved and had taken on a weepy appearance. The skin surrounding the wound

Received for publication, Nov. 4, 1943.

*The opinions or assertions contained therein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

†Records of Cases 2 and 3 were destroyed during combat and are reproduced from memory. The record of Case 1 is intact.

was covered with a weepy, vesicular rash. A diagnosis of sulfanilamide sensitivity was made and topical applications discontinued. Within ten days the wound was completely healed.

CASE 3.—A Marine officer received a small shrapnel wound of his back late in October, 1942. Treatment by his unit medical officer consisted of daily topical applications of sulfanilamide powder. This treatment was carried on until early December, 1942. At this time, the wound showed no improvement. He had developed a generalized vesicular rash, similar in appearance to that in Case 1. It was distributed over most of his body surface. Because of this condition he was evacuated to a base hospital out of the combat area.

On his return to his unit in February, 1943, he told me that when he arrived at the base hospital, sulfanilamide therapy was discontinued and he improved rapidly. Then, because he had developed a concurrent dysentery, he was given sulfathiazole by mouth. Within a day or two after being on sulfathiazole therapy, the rash reappeared, but rapidly disappeared when the sulfathiazole was discontinued.

COMMENT

There are a number of interesting points brought out by these cases. The first is how much sulfanilamide can be absorbed through a small, discharging wound. It is unfortunate that facilities to determine blood sufanilamide levels were not available. At least it is apparent that enough was absorbed to sensitize the patient.

From these three cases it would seem that the time required to develop a sensitivity to the sulfanilamide was roughly six weeks. That the patient may be sensitized to other sulfonamides is suggested in the story told by Case 3.

The diagnosis is not always easy in these cases, but once the history of the case is reviewed it becomes apparent. In Case 2, it was suspected before the rash became generalized, and by immediately discontinuing the sulfanilamide powder, a generalized rash was avoided.

In retrospect, it seems that in these cases the sulfanilamide powder inhibited epithelization of the wounds. Throughout these cases the slowness of epithelization was noted, but at the time the slowness of wound healing, so commonly seen in the tropics, was blamed.

It is obvious from a study of these cases that prolonged application of sulfanilamide powder to a wound is not without danger. Under combat conditions with the frequent transfer of patients and the tendencies to spend less time caring for the minor wounds, the dangers of sensitizing a patient to sulfonamides must not be forgotten. As the usual good results obtained from sulfonamides occur within a period of a few days, it seems advisable to discontinue the use of sulfanilamide in a wound after the maximal beneficial effects have been obtained, or if there is no improvement in the first five or six days, to discontinue its use anyway.

CONCLUSIONS

1. Three cases of vesicular dermatitis developing following sensitization to the continued application of sulfanilamide powder on small surface wounds have been presented.

2. The sulfanilamide also appeared to inhibit epithelization of the wounds.

3. Withdrawal of the sulfanilamide applications resulted in disappearance of the eruption and epithelization of the wounds.

4. These cases illustrated the potential danger to continued local applications of sulfanilamide.

5. As the beneficial effect of sulfanilamide occurs within a few days, it is suggested that local application of sulfanilamide to a wound be discontinued after five or six days.

AMINO ACIDS AND BLOOD CLOT RETRACTION

P. M. Aggeler, M.D., and S. P. Lucia, M.D., San Francisco, Calif.
(From the Division of Preventive Medicine, Department of Medicine, University of California Medical School)

DIMINISHED blood clot retraction usually occurs in patients suffering from thrombocytopenia and frequently in those with hypoprothrombinemia.[1, 2] Any medicament which would increase the degree of clot retraction, even though it did not correct the underlying cause, might be a desirable therapeutic agent. The effects of amino acids on blood clot retraction were recently studied by Rabinowitz,[3] who stated that the addition of 150 mg. of cysteine to 5 c.c. of normal blood, in vitro, would abolish clot retraction for more than twenty-four hours, and that 150 mg. of methionine, cystin, or glycine would neutralize the effect of the cysteine with resulting complete retraction of the clot within three hours. He also reported similar increases in the degree of blood clot retraction after the addition of these amino acids to samples of the blood of five patients suffering from "essential thrombocytopenic purpura." The oral administration of methionine (5 to 8 Gm. daily) to these patients was stated to have restored normal clot retraction and to have controlled spontaneous bleeding.* Subsequently, Rabinowitz used 5 Gm. of methionine in 1000 c.c. of 5 per cent glucose solution intravenously "in several severe cases of thrombocytopenic purpura with most gratifying results."[4]

We have attempted to repeat and extend these experiments and have been unable to confirm the observations of Rabinowitz.

METHODS

1. *Blood Clot Retraction.—The extracorpuscular volume of the clot,* a measurement of the fluid occluded within a blood clot, was determined by a method previously described.[2] The extracorpuscular volume of the clot is equal to the difference between the packed cell volume per cent and the volume of the retracted blood clot after incubation of the specimen for one hour at 37° C. The mean value is 9.1 per cent. Values of less than 25 per cent (within two standard deviations of the mean) are considered to be normal.

2. *Platelet Count.*—The method of Rees and Ecker was used and all counts were done by the same technician, who found a normal mean value of 422,000. Values between 248,000 and 596,000, that is, two standard deviations from the mean, are considered normal.

Received for publication, Oct. 28, 1943.

*A personal communication from Rabinowitz reveals that cysteine hydrochloride and not cysteine was used in these experiments. The substance to be tested was placed in the bottom of a test tube, the blood specimen was then added, and the blood allowed to coagulate. The tubes were not shaken or inverted.

TABLE I

EFFECT IN VITRO OF CYSTEINE HYDROCHLORIDE, CYSTIN, GLYCINE, AND METHIONINE ON NORMAL HUMAN WHOLE BLOOD, PLASMA, SERUM, AND ERYTHROCYTES

AMOUNT IN MG. ADDED TO 5 C.C. WHOLE BLOOD, PLASMA, OR SERUM				pH OF SERUM	DEGREE OF HEMOLYSIS OF ERYTHROCYTES	INHIBITION OF FIBRIN FORMATION IN PLASMA	GEL FORMATION IN SERUM OR PLASMA	EXTRACORPUSCULAR VOLUME OF BLOOD CLOT
CYSTEINE HCl	GLYCINE	CYSTIN	METHIONINE					
5				7.3	++	None	None	10
10				7.0	++++	Slight	None	14
15				6.6	++++	Slight	None	17
20				6.3	++++	Slight	None	22
25				5.9	++++	Marked	None	36
50				4.5	++++	Complete	Present	*
75				4.0	++++	Complete	Present	*
100				3.4	++++	Complete	Present	*
125				3.0	++++	Complete	Present	*
150				2.6	++++	Complete	Present	*
	150			7.4	0	None	None	10
		150		7.8	0	None	None	18
			150	7.0	0	None	None	7
50	50			4.5	++++	Complete	Present	*
50	150			4.5	++++	Complete	Present	*
50		50		4.5	++++	Complete	Present	*
50		150		4.5	++++	Complete	Present	*
50			50	4.5	++++	Complete	Present	*
50			150	4.5	++++	Complete	Present	*

*Impossible to measure because of complete absence of fibrin, hemolysis of erythrocytes, and alterations in the plasma.

3. *pH Determinations.*—The pH determinations of the amino acid-serum mixtures were made using a glass electrode-calomel electrode assembly, and the measurements recorded with a vacuum tube electrometer.[5]

4. *Effect of Amino Acids on Serum.*—The various amino acids were added in the desired concentrations to fresh normal human blood serum, thoroughly mixed and placed in a water bath at 37° C. for three hours.

5. *Effect of Amino Acids on Plasma.*—Human blood was drawn into syringes lined with vaselin and quickly transferred to paraffin-lined test tubes and centrifugalized for five minutes at 2,000 revolutions per minute. The supernatant plasma was transferred to test tubes, thoroughly mixed with the desired amount of the animo acids, and placed in a water bath at 37° C. for three hours.

6. *Effect of Amino Acids on Whole Blood.*—The desired quantities of the amino acids were placed in 15 ml. graduated centrifuge tubes to which were added 5 c.c. of freshly drawn human blood. The specimens were thoroughly mixed with a wooden applicator and placed in a water bath at 37° C. for one hour. These were examined and the extracorpuscular volume of the clot measured.

7. *Effect of Amino Acids on Erythrocyte Hemolysis.*—The desired concentrations of the amino acids were made up in 0.85 per cent sodium

TABLE II

BLOOD CLOT RETRACTION MEASUREMENTS AFTER THE ADDITION IN VITRO OF CYSTIN, GLYCINE, AND METHIONINE TO THE WHOLE BLOOD OF PATIENTS SUFFERING FROM THROMBOCYTOPENIA

CASE NO.	DIAGNOSIS	PLATELET COUNT	MG. OF SUBSTANCE MIXED WITH 5 C.C. SPECIMEN OF BLOOD IN VITRO			EXTRACORPUSCULAR VOLUME OF CLOT
			CYSTIN	GLYCINE	METHIONINE	
1	Chronic idiopathic thrombocytopenic purpura	41,000				51
			50			49
			150			48
				50		55
				150		50
					50	52
					150	55
2	Chronic idiopathic thrombocytopenic purpura	110,000				42
			50			38
			150			41
				50		44
				150		51
					50	39
					150	37
3	Chronic idiopathic thrombocytopenic purpura	67,000				39
			150			40
				150		61
					150	39
4	Polycythemia vera; secondary thrombocytopenic purpura from radioactive phosphorus	91,000				27
			50			31
			150			35
				50		31
				150		36
					50	31
					150	30
5	Postoperative carcinoma of uterus; secondary thrombocytopenic purpura from roentgen therapy	230,000				53
			150			46
				150		49
					150	53
6	Acute idiopathic thrombocytopenic purpura	51,000				41
			50			46
			150			45
				50		46
				150		47
					50	40
					150	43

chloride. Fresh human red blood corpuscles were added in quantities sufficient to make 2 per cent suspensions. The degree of hemolysis was recorded at the end of two hours at room temperature.

RESULTS

The results of the in vitro studies on the blood of normal subjects are summarized in Table I. Cysteine hydrochloride in the concentrations necessary to inhibit clot retraction strongly acidified the blood, hemolyzed the erythrocytes, coagulated the plasma proteins, and completely inhibited the formation of fibrin. None of these effects were noted with glycine, cystin, or methionine; furthermore they did not counteract any of the effects of cysteine hydrochloride.

TABLE III

BLOOD CLOT RETRACTION MEASUREMENTS AFTER THE ADMINISTRATION OF GLYCINE AND METHIONINE TO PATIENTS SUFFERING FROM THROMBOCYTOPENIC PURPURA

CASE NO.	DATE	DIAGNOSIS	PLATELET COUNT	EXTRACORPUSCULAR CLOT (VOLUME %)	REMARKS
1	9/23/42	Chronic idiopathic thrombocytopenic purpura	41,000	51	Control
	10/ 7/42		33,000	46	After oral glycine, 20 Gm. daily for 14 days
	10/ 7/42		30,000	45	1 hour after 20 Gm. of glycine in milk
	10/ 7/42		32,000	50	2 hours after 20 Gm. of glycine in milk
	10/14/42		36,000	47	After oral glycine, 30 Gm. daily for 7 days
	11/ 9/42		46,000	51	Before methionine
	11/ 9/42		43,000	52	Fifteen minutes after 5 Gm. of methionine in 1000 c.c. 0.85% NaCl given I.V.
	11/ 9/42		41,000	53	1 hour later
	11/10/42		43,000	53	18 hours later
2	11/ 6/42	Chronic idiopathic thrombocytopenic purpura	120,000	39	Control
	11/ 6/42		127,000	37	15 minutes after 5 Gm. of methionine in 1000 c.c. 0.85% NaCl given I.V.
	11/ 6/42		121,000	39	1 hour later
	11/ 7/42		120,000	40	24 hours later
	11/16/42		120,000	41	10 days later
	11/21/42		150,000	39	15 days later
6	10/28/42	Acute idiopathic thrombocytopenic purpura in recovery phase	280,000	26	Control
	11/ 4/42		250,000	18	After oral glycine, 30 Gm. daily for 7 days
	11/ 4/42		280,000	25	15 minutes after 5 Gm. methionine in 5% glucose given I.V.
	11/ 4/42		280,000	25	1 hour later
	11/ 5/42		270,000	20	18 hours later
	11/ 9/42		280,000	18	48 hours later
	12/ 2/42		480,000	9	Observations following spontaneous recovery
	12/19/42		350,000	9	

The results of the in vitro studies on the blood of six patients suffering from thrombocytopenia are given in Table II. Blood clot retraction was not significantly altered in any case following the addition of cystin, glycine, or methionine.

The results of the oral administration of glycine and the intravenous administration of methionine are given in Table III. Blood clot

retraction was not improved, nor was the frequency or severity of spontaneous bleeding altered in any of the three patients studied.

CONCLUSIONS

1. Cysteine hydrochloride inhibits blood clot retraction by acidification of the blood, hemolysis of the erythrocytes, coagulation of the plasma proteins, and complete inhibition of fibrin formation.

2. Cystin, glycine, and methionine do not counteract the effects of cysteine hydrochloride, nor do they increase the degree of blood clot retraction when added in vitro to the blood of patients suffering from thrombocytopenia.

3. The administration of glycine or methionine to patients suffering from thrombocytopenia does not increase the degree of blood clot retraction nor aid in the control of abnormal bleeding.

REFERENCES

1. Aggeler, P. M., Lucia, S. P., and Hamlin, L. H.: Blood Clot Retraction: I. Measurement of the Extracorpuscular Volume of the Clot, J. Lab. & Clin. Med. **28:** 89-97, 1942.
2. Lucia, S. P., Aggeler, P. M., and Hamlin, L. H.: Blood Clot Retraction: II. The Significance of the Extracorpuscular Volume of the Clot and Its Clinical Application, Am. J. M. Sc. **204:** 507-516, 1942.
3. Rabinowitz, H. M.: A Study of the Role of Amino Acids in Clot Retraction. The Effect of Methionine in Restoring Normal Clot Retraction and Control of Bleeding in Essential Thrombocytopenic Purpura, Am. J. Surg. **51:** 366-378, 1941.
4. Rabinowitz, H. M.: Personal communication.
5. Goyan, F. M., Barnes C. L., and Hind, H. W.: Universal pH Meter and Simplified Vacuum Tube Electrometer, Indust. & Engin. Chem. **12:** 482, 1940.

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

PROGRESS IN SURGERY OF THE AUTONOMIC NERVOUS SYSTEM, 1940-1942*

JAMES C. WHITE, M.D.,† BOSTON, MASS.

(From the Neurosurgical Service of the Massachusetts General Hospital and the Department of Surgery, Harvard Medical School)

THE war has nearly dried up the flow of articles in the Continental journals which deal with laboratory and clinical observations on the autonomic nervous system. Nevertheless, much work of interest continues to emanate from Great Britain, and the number of papers of value published in this country has barely begun to fall off. In spite of the difficulty of reviewing such a complicated subject while on active service with the Navy, I feel this task should be undertaken before an overwhelming mass of material has accumulated. In the present review an attempt is made, therefore, to summarize the more important laboratory and clinical findings that have been published during the three years since the previous report.[1] The reader who is particularly concerned with the anatomic and physiologic aspects of this branch of neurology should consult the excellent reviews by Hare and Hinsey,[2] whereas the monograph of White and Smithwick,[3] published in 1941, is available for the clinical investigator and the physician who wish to review the fundamental aspects of the field and their clinical application in a single volume. In no field has the surgeon been more indebted to recent contributions of the anatomist and the physiologist.

ANATOMY AND PHYSIOLOGY

As in the somatic system, autonomic reflexes are integrated by the central nervous system according to the principle of functional levels. This interesting analogy was pointed out by Fulton,[4] who developed the simile further by pointing out that only simple vasomotor, visceral, and sexual reactions are integrated at the spinal level, whereas at the level of the medullary stratum are organized the reflexes essential for the maintenance of a constant blood pressure. Other combined reactions such as salivation and vomiting, also developed at this level, repre-

*This article has been released for publication by the Division of Publications of the Bureau of Medicine and Surgery of the U. S. Navy. The opinions and views set forth are those of the writer and are not to be construed as reflecting the policies of the Navy Department.

†Captain, Medical Corps, U. S. Naval Reserve.

sent combined reactions of the autonomic and somatic systems. The hypothalamic level is far more complex. Here take place temperature regulation, determination of estrus, control of carbohydrate, fat, and water metabolism (see articles which were presented in the symposium on the hypothalamus before the Association for Research in Nervous and Mental Disease[5]). Fulton further summarized the evidence for a rich and varied representation of autonomic activities in the cerebral cortex. Disturbances of visceral activity, metabolism, etc., which have been produced by lesions of the frontal areas, indicate that in man the hypothalamic level is under the direct control of the cortex.

Another proof of cortical dominance over the hypothalamus is the intensive autonomic discharge which is released when these higher centers are removed by decortication. The term "sham rage" was originally suggested by Cannon and Britton[6] to describe the spontaneous outbursts of motor activity in cats which occur when the cortex is disconnected from the lower hypothalamic centers and resemble responses to rage and fear. Wortis and Maurer[7] have recently described this phenomenon in two human cases after destruction of the higher centers by insulin hypoglycemia and by carbon monoxide poisoning. In both cases the emotional outbursts were in no wise purposeful and therefore appeared to be an uninhibited discharge of the autonomic centers in the hypothalamus. Sjöqvist[8] suggests that hypothalamic discharge may occur under pathologic conditions, in connection with ordinary epileptic seizures, and also in acute obstructions of the cerebrospinal fluid pathways. The syndrome originally referred to by Penfield[9] as diencephalic autonomic epilepsy Sjöqvist believes is due to acute distension of the third ventricle with stimulation of the autonomic nuclei which lie within its walls. There has arisen a tendency even among psychiatrists to stress unduly the role of the hypothalamus in the emotional aspects of behavior. Masserman,[10] however, rightly points out that in the present state of knowledge it would seem safest to assign to the hypothalamus its experimentally demonstrable role in re-enforcing and coordinating the neutral and hormonal mechanisms of emotional expression, and reserve for more adequate proof the hypothesis that it is either the dynamic source or the seat of experience of affective states. "An emotion is a highly complex conative and cognitive as well as affective state in which not only the central nervous system but the entire organism functions as a psychobiologic whole."

A verification in man of earlier experimental evidence pointing to the hypothalamic control of the waking-sleep rhythm is a finding of much clinical interest recently stressed by Globus.[11] In an analysis of two patients studied clinically and anatomically it was observed that protracted somnolence was a striking symptom, and at post-mortem circumscribed lesions were discovered in the diencephalic-mesencephalic region. These lesions were situated bilaterally and corresponded closely

in location to the experimental lesions produced by Harrison[5] in cats. There is still greater accord with the area outlined by von Economo as the center for regulation of sleep. Globus concludes that, although the importance of the more caudal parts is still subject to discussion, it seems probable that the periventricular hypothalamic gray matter is the area containing cell aggregations which functions as a sleep-regulating center.

The position of the descending pathway of the sympathetic fibers in the medulla, located experimentally in animals by Magoun,[5] has been confirmed in man by an observation of Duthie and Mackay.[12] In measuring skin temperatures of the extremities in a patient after thrombosis of the left posterior inferior cerebellar artery, they found that the cutaneous vessels of the left hand remained fully dilated six months after the lesion occurred. The posterior inferior cerebellar artery supplies the medulla oblongata in the region dorsal to the inferior olive and lateral to the hypoglossal nucleus. In addition they noted miosis and absence of sweating of the left arm and face. The sympathetic fibers running from the hypothalamus to the lateral horn cells traverse this area and constitute the highest neurone of the sympathetic nervous system. They do not cross below this level, and the fact that vasodilatation is complete shows that there can be little if any autonomous activity in the lower spinal centers or in the chain of peripheral sympathetic ganglia.

An exact knowledge of the segmental outflow of the vasoconstrictor and sudomotor fibers from the spinal cord is of the greatest importance for successful operative treatment of Raynaud's disease and hyperhidrosis. This had been based on experiments in lower animals performed by Langley, in 1891.[13] With modern electrical methods of recording nerve impulses, Sheehan,[14] Sheehan and Marrazzi,[15] and Geohegan and associates[16] have investigated the segmental outflow in the monkey and man by stimulating the anterior spinal roots. In man it is now established that the highest vasoconstrictor fibers to the upper extremity emerge in the second thoracic nerve and are present in each succeeding anterior root down to the ninth or tenth thoracic level. Exception has been taken to these findings by Kuntz and Dillon,[17] who claim to have demonstrated the presence of preganglionic sympathetic components in the first thoracic nerve in cats and monkeys. Kirgis and Kuntz[18] have stated that in certain cases there may even be a communicating ramus from the eighth cervical nerve which carries preganglionic fibers to the brachial plexus via the middle cervical ganglion. It is difficult to accept the validity of these observations, which are at variance with findings in many patients where the upper extremity has been totally sympathectomized, although the first thoracic ramus communicans has been left intact.

SYMPATHECTOMY IN PERIPHERAL VASCULAR DISEASE

Outstanding descriptions of peripheral vascular disease have been written by Scupham, de Takáts, Van Dellen, and Jesser[19*] and by Homans.[20] In the typical advanced case of Raynaud's disease, all observers are now in agreement with Lewis[21] that the phenomenon of intermittent color changes in the digits is due to abnormal contraction of the arterioles in direct response to cold. In these advanced cases, where blanching is caused by ischemia of the fingers, the digital arterioles are the seat of occlusive changes.[3] But before this stage is reached these patients usually have suffered from cold and more or less cyanotic extremities for a number of years, and the condition in the feet is not likely to advance beyond this point. As a rule the extremities are abnormally moist and the sweat glands, which are activated by the sympathetic nervous system, respond excessively to emotional stimuli. In the cases where Raynaud's crises of pallid asphyxia are not present, all gradations are seen between a pink, moist, warm hand and a cyanotic wet one. The latter condition is commonly classified as acrocyanosis and resembles Raynaud's disease, except that there are no episodes of blanching. Furthermore, the trophic changes, ulceration, and gangrene, which appear in the most severe cases with complicating scleroderma, have not been reported in true acrocyanosis. The causative factor in this condition, as well as in true Raynaud's disease, has been attributed by Lewis[21] to a local fault in the blood vessels, and he also believes that constrictor impulses play little part in its production. Barker and Baker[22] have described in detail a typical case of acrocyanosis in which the incapacitating symptoms and color changes disappeared after sympathectomy. They feel, as do White and Smithwick,[3] that vasomotor impulses are the primary initiating factor in the production of arteriolar spasm. The closely related syndrome of hyperhidrosis, in which the hands are excessively sweaty as well as frequently cold and cyanotic, is equally amenable to sympathectomy. In this condition there can be no question as to the etiologic role of the sympathetic nervous system. The sweat glands are activated by sympathetic impulses and are in no way susceptible to the direct effects of cold.

A confusing factor in evaluating the role of the sympathetic vasoconstrictor fibers in Raynaud's disease has been the all too frequent poor relaxation of the blood vessels in the upper extremities following attempts at sympathetic denervation. The fact that vasoconstriction is nearly always abolished in the lower extremities after resection of the lumbar ganglia has been conveniently overlooked by writers such as Hyndman and Wolkin.[23] Johnson,[24] after studying twenty-two patients with Raynaud's phenomena, has even reached the conclusion that sympathectomy has been a complete failure and that circulation (tested

*This extensive review has been written in two parts; the first, which summarizes recent literature, is written by Van Dellen and Scupham; the second, on surgical treatment, by de Takáts and Jesser.

by the finger phethysmograph) returns to the preoperative level in a short time. He presents five case reports in support of this statement. A critical examination of his account reveals that two patients were operated on when indications for surgery were doubtful (cases of rheumatoid arthritis and of syphilitic endarteritis); the conclusions are based on operative results in the upper extremity, and in several of his cases the operations were manifestly incomplete.* Furthermore, his observations were not carried out under constant basal conditions, and the surface temperature of the fingers before operation was so high that normal vasoconstrictor tone must have been nearly abolished. These faulty observations have been criticized in detail by de Takáts and associates[19] and by Smithwick.[25] Johnson's plethysmographic pulse volume curves, which show a rapid return to the preoperative deficient level of blood flow, are in striking contrast with those obtained after anatomically complete and physiologically effective types of denervation, provided these determinations are made under conditions where vasoconstrictor tone would normally be present.

Out of the extensive clinical and experimental evidence collected in the past decade has emerged the fact that certain fundamental principles must be observed by the surgeon in order to get the best clinical results (Smithwick[25] and White and Smithwick[3]). First, it seems clear that the operation must thoroughly interrupt the sympathetic vasoconstrictor fibers. If even a few remain intact, secretion of sympathin at their endings is capable of exciting contraction in all the denervated smooth muscle cells in the vascular walls. In the second place, the best results have been obtained by the interruption, as far as possible, of preganglionic fibers only. This fundamental physiologic principle has been corroborated by Learmonth,[26] de Takáts and associates,[19] Atlas,[27] and numerous other students of peripheral vascular disease. In the third place, time has demonstrated conclusively the tremendous regenerative power of interrupted sympathetic fibers, especially after the preganglionic axone has been divided. These principles are adequately fulfilled when the second and third lumbar ganglia are resected, as they carry only preganglionic components to the sciatic nerve and their removal produces a gap of sufficient length to prevent regeneration. It is important to remember that bilateral removal of the first and second lumbar ganglia is likely to result in sterility in the male through paralysis of the ejaculatory mechanism, but the resection must include the first lumbar ganglion in order to produce a maximal increase in circulation through the upper leg. Its removal is therefore necessary in cases of thromboangiitis obliterans and in high arterial ligations, but it should be spared in the ordinary case of vasospasm, where increasing the circulation below the ankle is all that matters. The various types

*The assumption that the denervation must have been incomplete is based on the fact that either sweating or vasodilatation after nerve block were demonstrated soon afterward, and in one case the vasomotor paralysis was so brief that it did not outlast the traumatic effects of the operation.

of surgical approach and management of the important ganglia necessary to sympathectomize the arm and leg have been described by Ochsner and DeBakey.[28] The best description of the problems involved in preganglionic sympathectomy of the arm and the prevention of regeneration has been given by Smithwick.[29] He advocates division of the chain below the third thoracic ganglion and intradural division of the second and third thoracic anterior spinal roots so that their subsequent outgrowth will be checked by an intact dura. In order to prevent reconnection of the two divided ends of the chain, Smithwick has been covering the mobilized upper portion of the trunk with a cylinder of fine silk and transplanting its free lower end into the muscles of the back. While the results of this operation have been distinctly superior to those of the older method of cervicothoracic ganglionectomy, occasional recurrences of vasoconstrictor tone are seen after a period of months, due to regeneration. The suggestions of Atlas[30] and of Hyndman and Wolkin[31] that an effective sympathectomy of the arm can be carried out by removing only the second thoracic ganglion are open to the criticism that the fibers interrupted over such a short extent are nearly certain to regenerate.*

It should be frankly admitted that the problem of regeneration of the preganglionic fibers after upper extremity sympathectomy has not been entirely solved. Geohegan and Aidar[32] have made the intriguing suggestion that recovery of sympathetic tone may not necessarily be due to regeneration, but to reorganization of function within the sympathetic system itself; that the first thoracic root, which ordinarily carries no vasoconstrictor fibers to the upper extremity, may develop such a function. They cite a case in which the patient was operated upon by Ray.[33] The ventral roots from the second through the ninth thoracic root were sectioned (all the roots which gave a decrease in electrical skin resistance on direct stimulation), with subsequent evidence of complete sympathetic denervation of the hand. Within ten weeks, however, evidence of returning function was clear-cut. The shortness of this interval suggested that it might have come about in some other way than through regeneration of axones. An analogous situation was created in cats, and it was found that after interruption of preganglionic pathways to the forepad, new pathways developed from higher spinal roots, which normally contribute no outflow to the upper extremity. The implication of this theory is that, although the first thoracic root normally gives off no demonstrable vasoconstrictor impulses to the upper extremity, it may develop such a function after the usual pathways have been interrupted. This concept may fit in with Kuntz and Dillon's[17] findings quoted in the section on anatomy. While surgeons are in agreement that recovery of vasoconstrictor tonus is still a problem after preganglionic sympathectomy, many are not aware

*Three patients in whom White removed both the second and third thoracic ganglia showed clear-cut regeneration within a period of six to nine months.

of the fact that recurrence may also take place after cervicothoracic ganglionectomy, an operation which destroys most of the postganglionic cells sending fibers to the brachial plexus. This has been described by Sheehan[34] and also by White and Smithwick.[3]

It has been suggested by Fatherree, Adson, and Allen[35] that "adrenaline sensitization" does not satisfactorily explain the poor results of cervicothoracic ganglionectomy in Raynaud's disease and that there is no particular advantage in performing the preganglionic type of sympathetic denervation. This contradicts firmly established physiologic principles and is at marked variance with clinical findings in a large series of patients investigated by the peripheral vascular clinic at the Massachusetts General Hospital. White and Smithwick[3] have recorded how cervicothoracic ganglionectomy (postganglionic denervation) had to be given up in 1935 because vasoconstrictor activity recurred so frequently within a period of two weeks following operation through the direct action of circulating sympathiomimetic hormones. In monkeys, after cutting the anterior spinal roots from the second to the tenth thoracic roots, which carry the preganglionic vasoconstrictor fibers to the upper extremity, White (see discussion of paper by Smithwick[29]) found that the hand remained vasodilated. But if subsequently the inferior cervical and the first and second thoracic ganglia, which contain the cells of the postganglionic vasoconstrictor fibers, were resected, the hand cooled to nearly room temperature whenever the monkey became excited or small amounts of adrenaline were injected. The same unfavorable response was demonstrated by Ascroft,[36] in the lower extremity of a monkey by destroying the postganglionic cells after a successful preganglionic sympathectomy. Atlas[27] has recently confirmed this phenomenon in a human subject by performing a preganglionic sympathectomy in a man with paralysis of the median nerve, who suffered from aching pain, coldness, and cyanosis in the area to which the postganglionic fibers had been destroyed. Ten months afterward, the intravenous injection of adrenaline caused a drop in surface temperature of 4.1° (F.) of the fingers which had been sensitized by postganglionic denervation, and a fall of only 1.2° in the little finger.

In occlusive vascular disease of the extremities an abnormal degree of vasospasm may be an added factor that leads to gangrene. Surgical intervention upon the sympathetic nervous system is very helpful in the management of some of these patients.[3, 25] While arteriosclerosis in diabetics is almost never associated with a significant degree of vasospasm, thromboangiitis obliterans frequently has a large element of arterial spasm. This is also occasionally the case in uncomplicated arteriosclerosis. In dealing with these patients it is preferable to demonstrate by one method or another that the circulation can be improved before recommending sympathectomy. There is, however, a small group in which preliminary tests do not indicate a striking release of vaso-

spasm and yet experience has shown that sympathectomy may still be surprisingly worth while. At present these can only be selected on the basis of a wide clinical experience.

Sympathectomy has been employed by the peripheral vascular clinic at the Massachusetts General Hospital with increasing frequency in cases of thromboangiitis obliterans, generally in combination with other forms of treatment such as minor amputation of digits and crushing of peripheral nerves. Statistics of patients with the disease sufficiently advanced to require hospitalization[3] show that when only nonsurgical preliminary treatment was used (rest, vascular exercises, cessation of smoking) the proportion of major amputations amounted to 74 per cent. After the value of crushing peripheral nerves was recognized in 1930, the need for major amputations dropped to 30 per cent. Without adding any therapeutic method of importance except the release of vasospasm by sympathectomy, the incidence of major amputations has fallen to 15 per cent in the last ten years. While lumbar sympathectomy has been found to reduce the need for leg amputation when the popliteal artery is obliterated from 47 to 13 per cent, it is usually of no avail when all main vessel pulsations including that in the femoral artery are lost, especially when ulceration, infection, and gangrene are already present.

New applications of sympathectomy in other forms of peripheral vascular disease have been proposed during the last three years. In thrombophlebitis the role of reflex vasospasm and the therapeutic value of its release by procaine infiltration of the regional sympathetic ganglia, originally proposed by Leriche and Kunlin,[37] has been effectively demonstrated by Ochsner and DeBakey.[38] They point out that the concept of mechanical blockage of the venous and lymphatic trunks fails to explain the entire clinical picture; that many of the symptoms and signs are due to spasm of the arterial and venous systems; and that the vasoconstricting stimuli originate in the thrombophlebitic segment. As a result, filtration pressure is raised, capillary permeability is increased by anoxia, and flow of lymph is diminished. Re-establishment of a more normal exchange of intravascular and perivascular fluids can be produced by paravertebral infiltration of the sympathetic ganglia with procaine hydrochloride. Whereas in phlegmasia alba dolens there is often pyrexia for four to six weeks, a sense of painful distension of the tissues, and the likelihood of persistent edema, varicosities, and ulceration, there was a striking contrast in the cases treated by injection. Pain was relieved promptly in all instances. There was a more rapid return to normal temperature and disappearance of edema. Sixty per cent of the patients were discharged from the hospital as cured within eight days of the first therapeutic procaine block.

Erythromelalgia, a rare condition in which the lower extremities become red, hot, and painful, is not usually amenable to medical treatment and may be a cause of prolonged incapacity and discomfort. Tel-

ford and Simmons[39] have reported two patients who have been relieved of all their symptoms and signs by resection of the lumbar sympathetic chains.

Intermittent claudication, another condition which may incapacitate older individuals, is caused by the pain which develops in working muscles in the absence of an adequate circulation. Opinion has been divided concerning the efficiency of lumbar sympathectomy for relieving the pain and increasing the walking distance. Freeman and Montgomery[40] have measured the severity of intermittent claudication in twelve patients with obliterative vascular disease, both before and after blocking the sympathetic ganglia with procaine. Of this number, six who obtained relief from paravertebral injection were subsequently subjected to lumbar sympathectomy. Particular efforts were made to include the first lumbar ganglia, as this is essential to ensure vasodilatation of the arterial tree above the knee. Immediate and persistent relief was obtained in five out of the six cases. Similar favorable results have been recorded by White and Smithwick,[3] only these observers found that an unsatisfactory response to diagnostic procaine block does not necessarily preclude a satisfactory result after permanent denervation. One may conclude that, although it is true that intermittent claudication is caused by arterial occlusion, which is usually organic in nature, in many cases there may be a superimposed element of abnormal constriction which aggravates the circulatory deficiency, and that a high lumbar sympathectomy can often benefit these cases. One is tempted to ask why such improvement should occur, when the physiologists report that an increase in circulation through muscle is brought about by sympathetic stimulation or the secretion of adrenaline. Freeman and Montgomery believe that this apparent contradiction is explained by the fact that, although sympathetic stimulation dilates the muscle capillaries, at the same time it constricts the arterioles and larger arteries of the leg to such an extent as to interfere with the delivery of blood to those capillaries.

The reports of surgeons who have been forced to ligate the major arteries of the extremities at points where subsequent gangrene is a serious risk have brought out with increasing emphasis the protective value of preliminary or concomitant sympathectomy or other methods of abolishing vasoconstrictor tone in the early period before a collateral circulation is established. Learmonth[41] has summarized the value of removing vasoconstrictor tone over this critical period. This may be accomplished temporarily by two methods: by heating a sufficient area of the body, excluding the threatened area (which should be kept cool), to ensure reflex vasodilatation; or by injecting procaine solution followed by 95 per cent alcohol about the sympathetic fibers destined for the threatened limb. He adds that when either the femoral or the popliteal artery must be permanently occluded, if the patient's condi-

tion permits, it is wise to combine any operative procedure on the vessel with a sympathectomy. This not only provides the maximum collateral circulation at the critical period, but also is a good investment for the future nutrition of the limb. Arguing along these lines, Veal[42] has pointed out that, whereas the postoperative circulation may be adequate when the patient is at rest in a warm environment, it may yet be wholly inadequate under the stress and strain of normal function. The surprising effectiveness of this procedure is brought out in an article by Richards and Learmonth,[43] who quote skin temperature readings in a case of popliteal aneurysm before and after a preliminary lumbar ganglionectomy and after radical excision of the aneurysmal sac. For ten hours after resection of a portion of the popliteal artery and three of its five collateral branches, skin temperature records were taken from the great toes. After remaining at or near the level of the environment for five hours, the temperature of the great toe on the side of the operation rose gradually. Twenty-four hours after operation, in a room at 70° F., its temperature had reached 92° F., and ten days later it was 7° warmer than the control area on the opposite side. These records show the adequacy of the collateral circulation resulting from a preliminary elimination of the sympathetic vasoconstrictor tone. Similar dramatic results have been reported by Atlas[44] in a case of excision of a traumatic aneurysm which extended from just below the origin of the internal iliac artery to a point just short of the origin of the deep femoral. For thirty-five years following the ligation of the superficial femoral artery this patient had suffered from severe ischemia of the foot and leg with chronic ulceration, and the aneurysm had reached an alarming size. Six months after its excision, which included the total length of the external iliac and femoral arteries, the foot was pink and warm, the leg ulcers had remained healed, and there were no symptoms of ischemia other than a mild degree of intermittent claudication. From the surgical clinic of Tulane University, Gage[45] reports that in fifteen cases of arterial and arteriovenous aneurysms, collateral circulation has been rapidly developed and maintained by either injection or ablation of the regional sympathetic ganglia. He advocates alcoholic injection of the lumbar ganglia and either repeated injection of the upper thoracic ganglia with procaine or their resection, as injection of alcohol in this region is likely to be followed by neuritis. After a preliminary excision of the upper lumbar sympathetic ganglia, Leriche[46] has been able to resect the terminal portion of the aorta and common iliac arteries in two patients without jeopardizing the circulation to the lower extremities.

SUDOMOTOR MECHANISMS

The occurrence of excessive and incapacitating sweating in the palms of the hands and soles of the feet is due to abnormal activity on the part of the autonomic nervous system and has been consistently relieved

by sympathectomy. Two interesting cases of hyperhidrosis localized in a single hand and caused by irritation of the brachial plexus by a cervical rib have been reported by Telford.[47] The phenomenon disappeared after removal of the accessory rib. Gurney and Bunnell[48] have made a study of the sweat glands after denervation and found that no visible histologic change results. This explains why these glands are able to start functioning again months after nerve injury if the sympathetic fibers regenerate. Even when totally denervated, the glands are able to respond to intracutaneous injections of mecholyl or to excessive local stimulation by heat. Hyndman and Wolkin[49] state that sweating may occur on two surfaces of sympathectomized skin which are in contact, such as the axilla or antecubital fossa when the forearm is flexed. In a study of the anterior spinal roots over which sudomotor impulses emerge, these writers find that the second thoracic root carries the greatest number of fibers to the head and upper extremities. Section of the upper five anterior thoracic roots bilaterally causes almost complete anhidrosis of the face and hyphidrosis down to the second dorsal segment, whereas section from the third to the ninth inclusive does not noticeably diminish sweating. As is true of preganglionic sympathetic axones in general, the sweat fibers in any anterior root are distributed to at least four or five sympathetic ganglia. In the spinal cord, complete section of the anterior and anterolateral columns does not diminish sweating unless the result is complicated by injury to the pyramidal tracts. Hyndman and Wolkin conclude that the autonomic tracts which subserve sweating are probably situated just anterior and close to the pyramidal tracts. While complete transverse myelitis at the eighth cervical segment abolishes thermoregulatory sweating, the sweat glands regain their activity if the descending tracts recover. When sweating is lost over a large portion of the body, the activity of the remaining normal glands shows a great compensatory increase.

In a second article on sweating, Hyndman and Wolkin[50] point out that pilocarpine in $\frac{1}{5}$ gr. doses is a valid method of differentiating between paralysis of pre- and postganglionic fibers. Provided that sufficient time for fiber degeneration has elapsed following a postganglionic denervation, the areas of anhidrosis after a hypodermic injection of the drug will agree precisely with the loss of thermoregulatory sweating, whereas after a preganglionic denervation pilocarpine will induce copious secretion of sweat by its peripheral action. Perhaps the simplest method of outlining areas of skin which have been sympathectomized is by the alteration of electrical resistance. While the increase in cutaneous resistance that follows sympathetic denervation has been known for some time, Richter and Woodruff[51] have simplified and popularized the method of mapping out areas of high skin resistance by the passage of a very small direct current. The sharp demarcation between the denervated areas and the surrounding skin of normally low resistance is a most convenient test. Wherever the sweat glands are para-

lyzed, skin resistance is increased. In this way it is possible to map out the affected areas of body surface after injuries to the spinal cord, peripheral nerves, or sympathetic pathways.

IRRITABLE CAROTID SINUS

Most persons who have an abnormally active carotid sinus suffer only mild symptoms which can be relieved by simple nonoperative procedures, such as the avoidance of a tight collar and of sudden turning of the head, or administration of atropine and mild sedation. But there are a few individuals with such an irritable reflex that they suffer from attacks of asystole and hypotension which lead to syncope, or they may develop severe convulsive seizures with loss of consciousness. Diagnostic compression of the region of the carotid bifurcation should be tested in all individuals who suffer from unexplained heart block, syncopal attacks, or unusual epileptic seizures, especially if they are of arteriosclerotic age. This reflex syndrome responds remarkably to denervation of the carotid sinus. To the long list of successful results published in recent years, a number of interesting cases have been added by Mulholland and Rovenstine[52] and by Ray and Stewart.[53] An unusual case of atypical epilepsy has been reported by Romano, Stead, and Taylor,[54] in which preoperative electroencephalographic studies made during pressure over the carotid bifurcation showed changes compatible with psychomotor and grand mal seizures. In this and in another similar case reported by White and Smithwick[3] the abnormal brain waves as well as the seizures were relieved, temporarily by diagnostic procaine block, and permanently by surgical denervation. In Ray and Stewart's article it is also brought out that a hypersensitive carotid sinus reflex may be associated with tuberculous cervical nodes. The serious complications that may result from operative manipulations of the sinus region should be borne in mind by every surgeon and anesthetist. These have been emphasized by Leger,[55] Weese,[56] and Ruzicka and Eversole.[57] Serious cardiovascular collapse may occur during drainage of cervical abscesses or during manipulation of the superior pole of the thyroid gland, especially if the sinus reflex has been sensitized by digitalis, or when gas, light chloroform, or barbiturate anesthesia is used. Even ether cannot be counted upon to abolish a hypersensitive sinus reflex, in which case recourse must be had to infiltration of procaine between the external and internal carotids. It would seem wise to submit every patient who is to undergo a cervical exploration to a preliminary test by compression of the sinus area.

SYMPATHECTOMY IN THE TREATMENT OF ESSENTIAL HYPERTENSION

In the three years since the preceding review the value of surgical intervention in the treatment of essential hypertension has been firmly established, and more effective methods of releasing vasoconstrictor tone in the lower half of the body have been worked out. In general,

as aptly summarized by Grimson[58] in his discussion of the surgical treatment of hypertension, the lowering of the blood pressure observed has been directly proportional to the extent of the sympathectomy and inversely proportional to the severity of the disease. The constriction of cutaneous blood vessels by the sympathetic vasomotor nerves has been recognized for many years, but current teaching has indicated that the far more extensive vascular tree to the muscles is dilated by sympathetic impulses and also by adrenine. This is undoubtedly true of the terminal vessels, but the recent re-examination of vasomotor control in the muscles of the forearm and calf by Wilkins and Eichna[59, 60, 61] has disclosed that reflex vasodilatation on warming and reflex vasoconstriction on cooling of the body are mediated by the sympathetic nervous system, as is the case with the cutaneous vessels to a far greater extent. These reflex changes are abolished by preganglionic sympathectomy and blood flow is stabilized at a point somewhere between the high and low levels observed in the normal state. Sympathetic denervation of the extremities, however, does not interfere with chemical and hormonal vasodilatation, which still takes place in muscles in response to exercise, local heating, and after the release of a tourniquet. These experiments, therefore, indicate that whenever the individual is cool or under certain types of strain, blood flow is decreased in the great mass of the muscles as well as in the skin. This is an added reason for extending the area of sympathetic denervation in hypertensive subjects through the diaphragm, so that the upper lumbar in addition to the lower thoracic ganglia can be removed and neurogenic vasoconstriction eliminated in the lower extremities as well as in the abdominal viscera.

According to Smithwick[3, 62] it seems clear that surgery has something worth while to offer the hypertensive patient. However, if consistent results are to be obtained, a radical denervation of the blood vessels in the lower half of the body must be carried out by removing the lower thoracic and upper lumbar sympathetic ganglia in addition to resecting the splanchnic nerves. The proof that this has been accomplished is established when there is a profound fall in blood pressure when the patient stands. It is obvious that when cardiac and renal functions are both significantly impaired no operation can be successful. Only an occasional patient over 50 years of age is suitable for operation. When the indications for operation are clearly defined, it is to be expected that a high percentage of patients will be benefited, as judged by persistent and significant lowering of blood pressure levels. Regression of eyeground changes, decrease in size of the heart, improvement in the electrocardiogram, increase in renal function, and relief of symptoms are noted. Time is beginning to show that life expectancy may be increased. This has certainly been true in cases of malignant hypertension and in patients with severe retinitis who have been submitted to adequate surgery before cardiac and renal functions have

been seriously impaired. Woods and Peet[63] have compared the postoperative survival rate of patients classified into four groups according to the severity of retinal changes with a similar control group treated medically, which has been described by Wagener and Keith.[64] In Group I (early hypertensives with normal fundi) the four patients operated upon were all alive at the end of five years, as against a 30 per cent incidence of mortality in the medically treated group. In Groups III and IV (with unmistakable angiospasm advancing to hemorrhages, exudates, and papilledema) the increased survival rate of the sympathectomized cases becomes very striking, as twenty-two out of thirty-three in Group III survived as against an 80 per cent mortality in the control group; and of the twenty-four patients in Group IV (with the malignant form of the disease), in which 88 per cent of the medically treated patients were dead at the end of eighteen months and only one survived for five years, one-half of the surgical group lived for over two years and one-third were alive after five years. In the Group II series, however, operation had no apparent effect on survival. This group was largely made up of cases of arteriolar sclerosis without angiospasm, and for these patients with high blood pressure, operation seemed to have little to offer. The outstanding need for more careful selection of cases is clearly shown in the statistics which have been reported by Rytand and Holman.[65] They employed Peet's type of intrathoracic sympathectomy in some forty patients suffering from malignant hypertension and in others with congestive heart failure, coronary occlusion, local renal pathology, and nephritis, as well as in a few cases with the essential form of the disease. No attention was paid to the usual contraindications, and patients were operated upon at any age, with the result that a significant fall in blood pressure was obtained in only two cases.

The operations in current use for relief of hypertension vary considerably in extent. They fall into three main groups: (a) supradiaphragmatic ganglionectomy and splanchnicectomy as employed by Peet and described by him and his colleagues,[66, 67] (b) the subdiaphragmatic operation of Allen and Adson,[68] and (c) the combined, more radical thoracolumbar denervation of Smithwick.[69] Both of the first two procedures are open to the objection that they do not completely denervate the lower half of the body, and it is furthermore very unlikely that the limited length of splanchnic fibers that can be removed from beneath the diaphragm is sufficient to prevent regeneration. In the postoperative results reported by Peet, 51 per cent of the patients developed a satisfactory reduction in blood pressure; in Adson's cases a similar improvement is reported in less than 40 per cent. But in Heuer and Glenn's[70] statistics the lasting reduction in blood pressure after these two procedures was far less impressive. The combined thoracolumbar approach of Smithwick[69] permits the removal of a great length

of the splanchnic trunks as well as of the ganglionated chains from the ninth thoracic down through the first or second lumbar segments. A most significant point is that, before adopting this somewhat more extensive procedure, Smithwick[3] had tried the more limited operations above and below the diaphragm. His results in these were not as satisfactory as those recorded in the reports of their advocates, but with the adoption of the combined operation in 1938, a significant improvement took place. In his last statistics, which were presented in the discussion of the article by de Takáts, Heyer, and Keeton,[71] Smithwick states that in his first series of thirty-eight patients followed from six months to two and one-half years, 71 per cent had a significant and persistent lowering of blood pressure. Even of the advanced patients in Groups III and IV, 60 per cent had a striking reduction in pressure. An outstanding feature of this operation is the striking fall in blood pressure when the patient stands. This orthostatic hypotension is of infrequent occurrence after operations of more limited extent above or below the diaphragm, and is a proof that the lower extremities as well as the abdominal viscera have been deprived of their normal vasoconstrictor tone.

Most impressive confirmation of the increased effectiveness of the more radical combined denervation has been given by de Takáts and his associates.[19] He states that in his hands supradiaphragmatic and infradiaphragmatic nerve sections gave only temporary results, or none at all; since adopting the combined more radical operation improvement has been achieved, not only in the patients with early and more moderately advanced disease, but also in those of Group III with retinal hemorrhages and detectable renal damage. The difficulty of comparing postoperative statistics of different surgeons in favor of a special procedure is well known, but when an impartial observer has given all a fair trial his conclusions are likely to have the greatest significance. Thoracolumbar sympathectomy is at the same time a more effective and a far less mutilating method of abolishing central vasoconstrictor tone in the caudal half of the body than cutting the corresponding anterior spinal roots. One reason for its greater effectiveness is that preganglionic fibers destined for the abdominal plexuses may leave the cord higher than its sixth thoracic segment, but these are interrupted when the paravertebral ganglia and splanchnic trunks are resected. Incomplete denervation probably accounts for the unimpressive late statistics of Heuer's cases treated by anterior rhizotomy.[70] Of these nineteen patients, all those who suffered from the malignant form of the disease died within three and three-quarters years. In the seven survivors with less severe forms of the disease, the blood pressure rose over a period of two to three years until it approached, but seldom reached, the preoperative level.

A further extension of surgical denervation to total sympathectomy has been advocated by Grimson.[58, 72, 73] In his preliminary experiments

with Wilson and Phemister[74] it was demonstrated that no operation short of total sympathectomy prevents the pressor response to neurogenic elevation of blood pressure which takes place on increasing intracranial pressure. These observations have been elaborated by Freeman and Jeffers,[75] who found that if the sympathetic denervation is extended upward to include the heart it will prevent the elevation of blood pressure produced by increased intracranial pressure. That various types of localized sympathetic denervation have not prevented neurogenic hypertension in dogs does not seem an adequate reason for adopting such an extensive operative procedure in man, unless the clinical results turn out to be far superior to the satisfactory and safe method of denervating the entire lower half of the body which has been proposed by Smithwick. The results reported by Grimson[58] have not as yet established his contention.

The mechanisms whereby sympathetic denervation of the abdominal viscera and lower extremities brings about a reduction in blood pressure, regression of retinal and renal changes, and relief of symptoms are still but poorly understood. It is particularly difficult to explain how improvement in the latter may come about when there is little or no lowering of the blood pressure. Recent studies on the correlation of vascular pathology observed in biopsy specimens taken from the kidneys and renal clearance in hypertensive patients treated by radical sympathectomy have cast doubt on the primary importance of reduced renal blood flow in the causation of the disease. These data, obtained by Talbott and his colleagues[76] in twenty hypertensive patients submitted to radical thoracolumbar sympathectomy by Smithwick, show "a significant correlation of renal clearance with the microscopic apperance of their respective renal tissues, i.e., the more severe the renal vascular disease, the more reduced were the glomerular filtration rate and the renal blood flow. In the cases with grade O and I renal vascular disease, the renal clearance observations were either normal or only very slightly reduced. Only in grade IV renal vascular disease was renal blood flow seriously reduced." It is therefore probable that the observations of Foà, Woods, Peet, and Foà,[77] which indicate that the effective renal blood flow in hypertensive patients is reduced nearly 50 per cent, must have been made in advanced cases of the disease, and Castleman and Smithwick's[78] examination of renal biopsies in 100 hypertensive patients has shown that vascular disease was absent or insignificant in 28 per cent and distinctly mild in an additional 25 per cent. From these observations they conclude that morphologic evidence of renal vascular disease in more than one-half these cases is inadequate to be the sole factor in producing the hypertension. It would seem more likely that in most instances the hypertensive state antedates the renal vascular lesion, although the latter, once established, may aggravate the hypertension.

The renal clearance determinations of Talbott and co-workers[76] and a number of other independent investigators[79, 80, 81] have shown beyond a doubt that sympathectomy does not bring about any increase in the basal rate of blood flow through the hypertensive kidney. However, Smithwick[3] has suggested that the operation may eliminate reflex constriction of the afferent renal arterioles, such as occurs whenever the individual assumes the upright posture. Furthermore, with the reduction of adrenal secretion by medullary denervation, constriction of the efferent renal arterioles must be decreased.

In conclusion, it must be stated that the most reasonable explanation for the decrease of arterial pressure which follows sympathectomy in hypertensive patients is the general reduction of the tone of smooth muscle in the denervated vascular bed (Smithwick).[3] The explanation offered by Corcoran and Page,[80] that there is a partial failure of venous return, seems much less likely since it applies only to the postural hypotension seen in the acutely denervated state. It does not account for the persistent lowering of blood pressure in the horizontal position which is generally associated with a lowering of the heart rate. While other methods for reducing high blood pressure, such as antipressor substances, may ultimately be developed, thoracolumbar splanchnicectomy with removal of the lower thoracic and upper lumbar sympathetic ganglia appears to be the most effective method of treatment known at present. Although it is not yet established that the results will be permanent, at least there is good reason to believe that the hands of the clock can be set back for a number of years in the majority of younger patients with hypertension who have not been permitted to progress to the stage of advanced degenerative changes in the arteries of the kidney, heart, and brain.

GASTROINTESTINAL TRACT

Knight's[82] experimental work with achalasia (cardiospasm) has shown that in the cat there exists a true sphincter mechanism at the cardiac end of the esophagus; that bilateral vagectomy reproduces the appearance of achalasia, and that sympathectomy prevents it. Because in dissection of cadavers it was found that the sympathetic nerve supply to the cardia is derived chiefly from the left side of the celiac plexus and distributed along the left gastric artery, Knight advocated excision of this artery with its surrounding plexus of nerves. Ochsner and DeBakey,[83] in their surgical considerations of achalasia, have collected nineteen instances in which this procedure has been employed, including one case of their own. The results in these were not impressive, there being partial improvement in only four. Mitchell,[84, 85] who has worked out the innervation of the stomach in the most minute detail, expressed the opinion that the high incidence of recurrence may be due to the great anatomic variation in the sympathetic fibers to this region.

In the broader experience with sympathetic denervation it is certainly true that the results are unsatisfactory unless the interruption of fibers has been anatomically complete.

While enthusiasm for treating congenital megacolon by sympathectomy has waned, considerable progress has been made in treating this condition by parasympathetic drugs. Law[86] points out that children below the age of 4 stand the necessarily extensive operation of surgical denervation poorly, and that in older patients, with marked colonic dilatation and a thin, weak musculature, operation is not often successful. He believes that parasympathetic stimulation, rather than a block of the sympathetic inhibitor axones, may be the best therapy. Parasympathetic stimulation affects the colon and its sphincters as a functional unit by causing contraction of the former and relaxation of the latter. The earliest parasympathomimetic drug to be produced was acetylcholine, but this is rapidly destroyed in the body by cholinesterase. Acetyl-beta-methylcholine chloride is more stable, but it must be given by injection and it is difficult to adjust the dosage to produce evacuation without causing toxic symptoms. The bromide, however, is more stable and may be given by mouth in doses of from 0.1 to 0.2 Gm. after breakfast and, if necessary, in midafternoon. Law reviews the successful treatment of six children suffering from Hirschsprung's disease with oral dosage of acetyl-beta-methylcholine bromide and liquid petrolatum. Two of these patients were able to discontinue the drug after three to nine months of treatment. A second corroborative report has been made by Barenberg, Greene, and Greenspan,[87] who have described a child with congenital dilatation of the colon observed continuously from the age of 3 months for four and one-half years. During this period the effects of various medical procedures, drugs, and surgery (an incomplete sympathectomy of the rectum and lower colon) were studied. The best results were obtained with the oral administration of mecholyl bromide (in the dosage given by Law) and mineral oil. The patient has been completely relieved of abdominal distension as well as constipation, and his physical development is progressing in a normal manner.

A much more common and acute form of intestinal atony is the distension which follows laparotomy. This is caused by reflex depression of the parasympathetic division of the autonomic nervous system. For its relief and, better still, its prevention, Gordon[88] recommends the postoperative administration of the parasympathetic stimulant, prostigmine, and reviews the previous articles which have appeared on this subject since 1931. The incidence and severity of postoperative abdominal distension were reduced in cases in which 1 c.c. of prostigmine methylsulfate 1:4000 solution (prostigmine prophylactic) was injected subcutaneously at intervals of four, six, or eight hours or more during the first three days after operation. The drug should, of course, not

be employed in cases of peritoneal infection or bowel obstruction, but it is claimed that patients who would not require the use of a cholinergic drug are not harmed thereby, and that postoperative intestinal distension is more easily prevented than treated.

While surgical interruption of the abdominal sympathetic fibers for visceromotor disorders is being regarded with diminishing enthusiasm, its value for the control of pain from various abdominal organs has been emphasized by White and Smithwick.[3] Examples are recorded of effective relief of intractable pain in: (a) metastatic carcinoma of the liver treated by paravertebral infiltration of alcohol around the six lowest thoracic ganglia on the right side, in a patient whose general condition contraindicated cordotomy; (b) penetrating ulcer of the posterior wall of the duodenum in two patients relieved by similar injections, where advanced coronary disease prevented a direct surgical attack; (c) pain secondary to postoperative atresia of the biliary ducts, and also peristaltic pain of unknown origin, relieved by splanchnicectomy and resection of the upper lumbar sympathetic ganglia. Although suitable cases of chronic abdominal pain for localized denervation must necessarily be rare, operations of this type are distinctly less mutilating and less subject to complications than section of the spinothalamic tracts. The outcome can be tested in advance by diagnostic procaine block, and patients with underlying cardiac or malignant disease who could tolerate no open operation can often be given satisfactory relief for the duration of their lives by destroying the sympathetic rami with alcohol.

POST-TRAUMATIC PAIN IN THE EXTREMITIES

Why certain causalgias, painful amputation stumps, and post-traumatic dystrophies (Sudeck's atrophy) should respond to sympathectomy and even to injection of procaine is yet to be explained. With the increasing number of cases reported it is evident that the response is often dramatic, and that sympathectomy is most likely to be effective when the blood vessels of the extremity are in a state of chronic vasodilatation or constriction. Similarly, it is apparent that the procedure is most often successful when the hand or foot is involved, and that few instances have been reported where pain above the elbow or knee has been relieved. These points suggest that sympathetic vasomotor reflexes are concerned and that their surgical or chemical block interrupts the efferent half of a reflex arc.

The underlying physiologic mechanisms have been reviewed by Miller and de Takáts.[89] It is possible that the painful stimuli which set up vasomotor reflexes travel centripetally through the sympathetic fibers. Atlas[90] has recently described a case where, after injury to the roots of the cauda equina, only the sympathetic nerve supply to the leg appeared to remain intact. This patient had a very cold, cyanotic, sweaty foot which was anesthetic but extremely painful. As the pain

disappeared after the sympathetic outflow was blocked, he concluded that the painful sensations must have originated in the blood vessels and that they reached the cord over sympathetic pathways. Hyndman and Wolkin[91] have also described two cases in which compression fractures of the second lumbar vertebrae had caused characteristic sensory-motor paralysis of the legs without interrupting sympathetic innervation. In both these patients some degree of sensory perception was retained, which the authors conclude must have been transmitted over sympathetic pathways. In addition, they observed that a sympathectomy greatly diminishes the aching, stinging pain of the hands and feet that results from exposure to cold. Heretofore, with the exception of Foerster and Leriche, all experimental and clinical investigators have denied that any afferent impulses from the extremities are carried by the sympathetic nervous system. It is possible that the pain in these extremely interesting cases may have reached the central nervous system over somatic fibers which remained intact in the deeper structures. A second hypothesis which has been suggested by Miller and de Takáts is that sympathectomy, by accelerating circulation, washes out a "pain substance" which has been described by Sir Thomas Lewis in his recent monograph on pain.[92]

Many impressive case reports have appeared in the last three years describing the encouraging response to surgical or chemical interruption of the sympathetic pathways. In cases of ligamentous sprains and periarticular contusions with vasomotor disturbances of the type leading to Sudeck's atrophy, the largest series has been assembled by Miller and de Takáts;[89] other valuable reports have been contributed by Atlas[90] and by Mahorner.[93] Further instances of intractable pain in the extremities have been classified as "minor causalgias" by Homans,[94] who emphasizes the effectiveness of the simpler procedures, such as repeated injection of procaine into a localized source of pain (as originally advocated by Leriche and Livingston) or infiltration of the stellate or upper lumbar sympathetic ganglia. White and Smithwick[3] have stated that if a favorable response is obtained with procaine, treatment by repeated injections should be given a thorough trial. Occasionally a single injection results in long-lasting relief. If relief is complete, but short-lived, sympathetic ganglionectomy is the procedure of choice. A favorable response may be expected when the extremity is cold, discolored, and moist, especially when the patient is benefited by local heat or fever therapy. Sympathectomy is also more likely to succeed in peripheral lesions, such as those which involve a finger, wrist, or foot, than when the pain comes from the shoulder or above the knee.

RELIEF OF PAIN IN ANGINA PECTORIS

The anatomy of the pain-carrying fibers from the heart is now so well understood[3] that sensory denervation can be counted upon to

relieve the suffering of angina pectoris in patients who have failed to respond to medical treatment. The effectiveness of cutting the upper four thoracic posterior spinal roots (Haven and King,[95] Ray[96]) or resecting the upper three thoracic sympathetic ganglia (White and Smithwick[3]), through which the sensory axones run, has been found to approach 100 per cent. In patients who are good enough operative risks to withstand these procedures there is no evidence that relief from pain has any but a favorable effect, and an adequate warning signal has not been lost. Unfortunately, the selection of suitable cases for these operations is not easy, and many of the worst sufferers have too poor a coronary circulation to withstand any major surgical procedure. For these, chemical destruction of the cardiac sensory fibers, as they traverse the upper thoracic sympathetic ganglia and their rami before joining the spinal nerves, is a fairly satisfactory substitute. The technique of paravertebral injection has been reported in detail by White.[97] More than sixty additional cases treated in this manner have been reported by Perlow[98] and by Levy and Moore.[99] Satisfactory relief is recorded in 73 per cent and 77.5 per cent, respectively, of their patients without a single death. In the latter series relief was marked and permanent in 47.5 per cent of the total number; eight of these have been followed for more than six years, two for nine years. Many of the patients who had been bedridden or confined to the house were able to resume an active life. Changes in the form of the electrocardiogram in the direction of normal suggest that interruption of the sensory pathways in certain cases may diminish or abolish spasm in the coronary bed. Levy and Moore conclude on the basis of this evidence, and in view of experiments on dogs by McEachern, Manning, and Hall,[100*] that it is probable that interruption of pathways for pain may exert a beneficial effect on the coronary circulation.

The treatment of intractable angina pectoris by sclerosing solutions injected at the sides of the upper thoracic vertebrae is open to the objections that it fails to produce an effective nerve block in some 25 per cent of cases, that it is usually followed by a varying degree of neuritis, and that it has on rare occasions resulted in injury to the spinal cord. The chemical irritation of the intercostal nerves cannot be avoided, but is a source of serious complaint in only 10 per cent and almost never lasts more than a few weeks. Complications from direct trauma to the cord in the course of paravertebral injection or from alcohol entering the subarachnoid space have been reported by Olsen[102] and by Hirschboeck and Gillespie.[103] In these, a typical Brown-Séquard paralysis developed instantaneously, which in one of Olsen's cases has lasted eighteen years. To avoid this most serious accident, White[97] recommended inserting the needles at least 3 cm. anterior to the transverse processes

*These investigators found that removal of cardiosensory pathways eliminates the pain and markedly reduces the mortality rate after sudden occlusion of the larger branches of the left coronary artery in the conscious dog. Although Yodice[101] has questioned these results, the more refined experimental technique of the Canadian workers makes me favor their contention.

(well anterior to the intervertebral foramina and spinal nerves), preliminary injection of procaine, and very slow infiltration of alcohol with frequent testing for evidence of spinal block. In experienced hands the treatment of severe angina pectoris with advanced coronary disease can be undertaken with minimum risk and with better than three chances out of four of securing satisfactory reduction in the severity and frequency of the attacks. In one-half the cases all pain will be abolished on the injected side. But when injection has failed or the patient's more favorable condition permits, surgical interruption of the nerves is unquestionably the procedure of choice.

SENSORY-MOTOR INNERVATION OF UROGENITAL TRACT

The most important work to be published on bladder innervation during the past three years is the monograph by Langworthy, Kolb, and Lewis.[104] Their investigations overthrow the older theory of antagonism between the sympathetic and parasympathetic innervations of the bladder and its sphincters. The sympathetic is confined to vasomotor supply and sexual functions (vesical neck, prostate, and seminal vesicles), and its activity is not essential to normal micturition. Stimulation of the sacral roots which contain the parasympathetic fibers produces contraction and emptying of the bladder. Micturition begins with a contraction of the bladder musculature, and only after the intravesical pressure rises does the internal sphincter open. The external sphincter opens later. This also is an involuntary act, and the only voluntary power of the so-called "voluntary" sphincter is to contract and postpone or stop urination. The clinical manifestations that are found after nerve lesions have been correlated with the functional levels of the central nervous system in a most logical manner by Evans.[105] Beginning at the highest level in the cortex, there is the fully integrated mechanism of micturition subject to inhibition by the person who can suppress the desire to void or who can initiate micturition at will. At the next lower level of function in the brain stem micturition occurs subconsciously, but may still be well coordinated. At the spinal level, following recovery from shock, a fairly well-coordinated activity may develop in time, but urination is mediated by spinal reflexes whenever the intravesical pressure becomes elevated and is therefore explosive in nature. Finally, there is the poorly coordinated, totally inefficient type of micturition seen in the isolated bladder after lesions of the cauda equina or pelvic nerves. Clinical examples after various neurogenic lesions and their interpretation by the cystometrogram are given in the monograph by McLellan.[106] Unfortunately, all this recent knowledge goes to show that sympathetic denervation is of no value in the treatment of the paralyzed bladder.

The same is largely true of the painful bladder, as the great majority of its sensory fibers run in the sacral nerves. Resection of the superior hypogastric plexus (presacral nerves) in no way alters the patient's

sensation as the bladder is filled.[3] In the few convincing cases where presacral neurectomy has reduced bladder pain, McLellan[106] believes that its action is through reduction of spasm in the vesical neck and trigone, areas which are innervated by the sympathetic.

In contrast to the bladder, sensory fibers from the kidney and ureter pass in large part through the sympathetic renal and splanchnic plexuses to enter the spinal cord over its lowest thoracic and upper lumbar roots.[3] Gunnar Bauer[107] reported eleven patients with renal pain, in whom denervation by sympathectomy produced relief. The pain had been present for long periods, and the operation was followed by no serious complications.

The recent application of high caudal anesthesia to obstetrics by Edwards and Hingson[108] has demonstrated that all sensory nerves from the uterus enter the spinal cord below its tenth thoracic segment. This goes back to the classical work on uterine innervation by Cleland,[109] in which he showed that the uterus derives its sensory nerve supply from two sources, the fibers to the fundus arising from the eleventh and twelfth thoracic spinal segments and passing through the preaortic and superior hypogastric plexuses, while the sensory fibers to the cervix are found in the parasympathetic plexus of sacral nerves. After presacral neurectomy, biopsies may be taken painlessly from the body of the uterus, but the cervix and tubes remain sensitive.[3] The nerve supply to the latter comes from the ovarian plexuses and descends along the ureters. The anatomic arrangement of the pelvic autonomic nerves has been described and clearly illustrated by Curtis, Anson, Ashley, and Jones.[110] While resection of the superior hypogastric plexus remains a satisfactory method of dealing with the most intractable cases of idiopathic dysmenorrhea, there have been no successful new applications of this method to report.

REFERENCES

1. White, J. C.: Progress in Surgery of the Autonomic Nervous System in 1938 and 1939, SURGERY **9**: 115-131, 1941.
2. Hare, K., and Hinsey, J. C.: The Autonomic Nervous System, Ann. Rev. Physiol. **4**: 407-444, 1942.
3. White, J. C., and Smithwick, R. H.: The Autonomic Nervous System: Anatomy, Physiology, and Surgical Application, ed. 2, New York, 1941, The Macmillan Company, 469 pp.
4. Fulton, J. F.: Les niveaux centraux de la fonction autonome, avec relations particulières avec les organes endocriniens, Rev. neurol. **72**: 360-361, 1939-40.
5. The Hypothalamus and Central Levels of Autonomic Function (Research Publ. A. Nerv. & Ment. Dis., vol. XX), Baltimore, 1940, Williams & Wilkins Company, pp. 980.
6. Cannon, W. B., and Britton, S. W.: Studies on the Conditions of Activity in Endocrine Glands: XV. Pseudaffective Medulliadrenal Secretion, Am. J. Physiol. **72**: 283-313, 1925.
7. Wortis, H., and Maurer, W. S.: "Sham Rage" in Man, Am. J. Psychiat. **98**: 638-644, 1942.
8. Sjöqvist, O.: Hypothalamic Discharge and Its Relation to Epilepsy, With the Report of a Case of "Sham Rage" in Man With Surgical Verification, Acta chir. Scandinav. **85**: 235-247, 1941.
9. Penfield, W.: Diencephalic Autonomic Epilepsy, Arch. Neurol. & Psychiat. **22**: 358-374, 1929.

10. Masserman, J. H.: Is the Hypothalamus the Seat of Emotion? (Trans. Chicago Neurol. Soc.) Arch. Neurol. & Psychiat. **45:** 896, 1941.
11. Globus, J. H.: Probable Topographic Relations of the Sleep-Regulating Center, Arch. Neurol. & Psychiat. **43:** 125-138, 1940.
12. Duthie, J. J. R., and Mackay, R. M. I.: Vasomotor Reflexes in the Control of Body Temperature in Man, Brain **63:** 295-320, 1940.
13. Langley, J. N.: On the Origin From the Spinal Cord of the Cervical and Upper Thoracic Sympathetic Fibers, With Some Observations on White and Grey Rami Communicantes, Philos. Trans., s. B. **183:** 85-124, 1892.
14. Sheehan, D.: Spinal Autonomic Outflows in Man and Monkey, J. Comp. Neurol. **75:** 341-370, 1941.
15. Sheehan, D., and Marrazzi, A. S.: Sympathetic Preganglionic Outflow to Limbs of Monkeys, J. Neurophysiol. **4:** 68-79, 1941.
16. Geohegan, W. A., Wolf, G. A., Jr., Aidar, O. J., Hare, K., and Hinsey, J. C.: The Spinal Origin of the Preganglionic Fibers to the Limbs in the Cat and Monkey, Am. J. Physiol. 135: 324-329, 1942.
17. Kuntz, A., and Dillon, J. B.: Preganglionic Components of the First Thoracic Nerve: Their Role in the Sympathetic Innervation of the Upper Extremity, Arch. Surg. **44:** 772-778, 1942.
18. Kirgis, H. D., and Kuntz, A.: Inconstant Sympathetic Neural Pathways: Their Relation to Sympathetic Denervation of the Upper Extremity, Arch. Surg. **44:** 95-102, 1942.
19. Scupham, G. W., de Takáts, G., Van Dellen, T. R., and Jesser, J. H.: Vascular Diseases: Seventh Annual Review, Arch. Int. Med. **68:** 599-660, 1941.
20. Homans, J.: Vascular Disorders of the Extremities, New England J. Med. **226:** 917-922, 1942.
21. Lewis, T.: Vascular Disorders of the Limbs Described for Practitioners and Students, New York, 1936, The Macmillan Company, 111 pp.
22. Barker, N. W., and Baker, G. S.: Acrocyanosis: Effect of Cervicothoracic Sympathectomy: Report of a Case, Proc. Staff Meet., Mayo Clin. **15:** 601-604, 1940.
23. Hyndman, O. R., and Wolkin, J.: Raynaud's Disease: A Review of Its Mechanism, with Evidence that It Is Primarily a Vascular Disease, Am. Heart J. **23:** 535-554, 1942.
24. Johnson, C. A.: A Study of the Clinical Manifestations and the Results of Treatment of Twenty-Two Patients With Raynaud's Symptoms, Surg., Gynec. & Obst. **72:** 889-907, 1941.
25. Smithwick, R. H.: Surgical Intervention on the Sympathetic Nervous System for Peripheral Vascular Disease, Arch. Surg. **40:** 286-306,1940.
26. Learmonth, J. R.: The Surgery of the Sympathetic Nervous System, Brit. J. Surg. **25:** 426-445, 1937.
27. Atlas, L. N.: Further Observations on the Etiology of Vasomotor Disturbances Following Peripheral Nerve Section, SURGERY **10:** 318-322, 1941.
28. Ochsner, A., and DeBakey, M.: Peripheral Vascular Disease: A Critical Survey of Its Conservative and Radical Treatment, Surg., Gynec. & Obst. **70:** 1058-1072, 1940.
29. Smithwick, R. H.: The Problem of Producing Complete and Lasting Sympathetic Denervation of the Upper Extremity by Preganglionic Section, Ann. Surg. **112:** 1085-1100, 1940.
30. Atlas, L. N.: The Rôle of the Second Thoracic Spinal Segment in the Preganglionic Sympathetic Innervation of the Human Hand—Surgical Implications, Ann Surg. **114:** 456-461, 1941.
31. Hyndman, O. R., and Wolkin, J.: Sympathectomy of the Upper Extremity: Evidence that Only the Second Dorsal Ganglion Need Be Removed for Complete Sympathectomy, Arch. Surg. **45:** 145-155, 1942.
32. Geohegan, W. A., and Aidar, O. J.: Functional Reorganization Following Preganglionectomy, Proc. Soc. Exper. Biol. & Med. **50:** 365-369, 1942.
33. Ray, B. S., Hinsey, J. C., Hare, K., and Geohegan, W. A.: The Spinal Origin of Preganglionic Sympathetic Fibers to the Pupil and Upper Extremity in Man, Tr. Am. Neurol. A. **1942:** 51-54.
34. Sheehan, D.: The Autonomic Nervous System, Ann. Rev. Physiol. **3:** 399-448, 1941.
35. Fatherree, T. J., Adson, A. W., and Allen, E. V.: The Vasoconstrictor Action of Epinephrine on the Digital Arterioles of Man Before and After Sympathectomy, SURGERY **7:** 75-94, 1940.

36. Ascroft, P. B.: The Basis of Treatment of Vasospastic States of the Extremities: An Experimenal Analysis in Monkeys. Brit. J. Surg. **24**: 787-816, 1937.
37. Leriche, R., and Kunlin, J.: Traitement immédiat des phlébites post-opératoires par l'infiltration novocaïnique du sympathique lombaire, Presse méd. **42**: 1481-1482, 1934.
38. Ochsner, A., and DeBakey, M.: Thrombophlebitis: The Role of Vasospasm in the Production of the Clinical Manifestations, J. A. M. A. **114**: 117-123, 1940; Therapy of Phlebothrombosis and Thrombophlebitis, Arch. Surg. **40**: 208-231, 1940.
39. Telford, E. D., and Simmons, H. T.: Erythromelalgia, Brit. M. J. **2**: 782, 1940.
40. Freeman, N. E., and Montgomery, H.: Lumbar Sympathectomy in the Treatment of Intermittent Claudication: Selection of Cases by Claudication Test with Lumbar Paravertebral Procaine Injection, Am. Heart J. **23**: 224-242, 1942.
41. Learmonth, J. R.: The Surgery of Blood Vessels, Edinburgh M. J. **47**: 225-240, 1940.
42. Veal, J. R.: The Value of Sympathetic Interruption Following Surgical Repair of Peripheral Aneurysms, M. Ann. District Columbia **9**: 227-230, 1940.
43. Richards, R. L., and Learmonth, J. R.: Lumbar Sympathectomy in Treatment of Popliteal Aneurysm, Lancet **242**: 383-384, 1942.
44. Atlas, L. N.: A Complicated Case of Aneurysm Involving the Iliac and Femoral Arteries, Ann. Surg. **116**: 708-712, 1942.
45. Gage, M.: Arterial Aneurysm of the Peripheral Arteries: Methods of Developing the Collateral Circulation, Tr. South. S. A. **52**: 257-268, 1940; The Development of the Collateral Circulation in Peripheral Arterial Aneurysms by Sympathetic Block, SURGERY **7**: 792-795, 1940.
46. Leriche, R.: De la résection du carrefour aortico-iliaque avec double sympathectomie lombaire pour thrombose artéritique de l'aorte; le syndrome de l'oblitération termino-aortique par artérite, Presse méd. **48**: 601-604, 1940.
47. Telford, E. D.: Cervical Rib and Hyperhidrosis, Brit. M. J. **2**: 96, 1942.
48. Gurney, R., and Bunnell, I. L.: A Study of the Reflex Mechanism of Sweating in the Human Being; Effect of Anesthesia and Sympathectomy, J. Clin. Investigation **21**: 269-274, 1942.
49. Hyndman, O. R., and Wolkin, J.: Sweat Mechanism in Man: Study of Distribution of Sweat Fibers From the Sympathetic Ganglia, Spinal Roots, Spinal Cord and Common Carotid Artery, Arch. Neurol. & Psychiat. **45**: 446-467, 1941.
50. Hyndman, O. R., and Wolkin, J.: The Pilocarpine Sweating Test: I. A Valid Indicator in Differentiation of Preganglionic and Postganglionic Sympathectomy, Arch. Neurol. & Psychiat. **45**: 992-1006, 1941.
51. Richter, C. P., and Woodruff, B. G.: Changes Produced by Sympathectomy in the Electrical Resistance of the Skin, SURGERY **10**: 957-970, 1941.
52. Mulholland, J. H., and Rovenstine, E. A.: Surgery in the Carotid Sinus Syndrome, SURGERY **9**: 751-757, 1941.
53. Ray, B. S., and Stewart, H. J.: Observations and Surgical Aspects of the Carotid Sinus Reflex in Man, SURGERY **11**: 915-938, 1942.
54. Romano, J., Stead, E. A., Jr., and Taylor, Z. E.: Clinical and Electroencephalographic Changes Produced by a Sensitive Carotid Sinus of the Cerebral Type, New England J. Med. **223**: 708-712, 1940.
55. Leger, L.: Le Danger Sinu-Carotidien des Interventions Cervicales, Presse méd. **48**: 451-453, 1940.
56. Weese, H.: Mechanism of Anesthesia Accidents Following Intravenous Use of Evipal Soluble, Barbital Derivative, in Sublingual Phlegmons (Rôle of Carotid Sinus), Anesth. & Analg. **18**: 15-21, 1939.
57. Ruzicka, E. R., and Eversole, U. H.: The Carotid Sinus in Anesthesiology: Report of Two Cases, Lahey Clin. Bull. **3**: 47-54, 1942.
58. Grimson, K. S.: The Surgical Treatment of Hypertension: Collective Review, Internat. Abstr. Surg. (Surg., Gynec. & Obst.) **75**: 421-434, 1942.
59. Wilkins, R. W., and Eichna, L. W.: Blood Flow to the Forearm and Calf: I. Vasomotor Reactions: Rôle of the Sympathetic Nervous System, Bull. Johns Hopkins Hosp. **68**: 425-449, 1941.
60. Eichna, L. W., and Wilkins, R. W.: Blood Flow to the Forearm and Calf: II. Reactive Hyperemia: Factors Influencing the Blood Flow During the Vasodilatation Following Ischemia, Bull. Johns Hopkins Hosp. **68**: 450-476, 1941.

61. Wilkins, R. W., and Eichna, L. W.: Blood Flow to the Forearm and Calf: III. The Effect of Changes in Arterial Pressure on the Blood Flow to Limbs Under Controlled Vasodilatation in Normal and Hypertensive Subjects, Bull. Johns Hopkins Hosp. **68**: 477-511, 1941.
62. Smithwick, R. H.: Surgery of the Autonomic Nervous System: Method of Study, with Particular Reference to the Interpretation of Clinical Results, New England J. Med. **226**: 605-612, 1942.
63. Woods, W. W., and Peet, M. M.: The Surgical Treatment of Hypertension: II. Comparison of Mortality Following Operation With That of the Wagener-Keith Medically Treated Control Series: A Study of Seventy-Six Cases From Five to Seven Years After Operation, J. A. M. A. **117**: 1508-1515, 1941.
64. Wagener, H. P., and Keith, N. M.: Diffuse Arteriolar Disease With Hypertension and the Associated Retinal Lesions, Medicine **18**: 317-430, 1939.
65. Rytand, D. A., and Holman, E.: Arterial Hypertension and Section of Splanchnic Nerves, Arch. Neurol. & Psychiat. **47**: 1052-1053, 1942.
66. Peet, M. M., Woods, W. W., and Braden, S.: The Surgical Treatment of Hypertension: Results in 350 Consecutive Cases Treated by Bilateral Supradiaphragmatic Splanchnicectomy and Lower Dorsal Sympathetic Ganglionectomy, J. A. M. A. **115**: 1875-1885, 1940.
67. Woods, W. W.: The Surgical Treatment of Hypertension: Results of Clinical and Experimental Investigations, J. Urol. **48**: 16-22, 1942.
68. Allen, E. V., and Adson, A. W.: The Treatment of Hypertension; Medical Versus Surgical, Ann. Int. Med. **14**: 288-307, 1940.
69. Smithwick, R. H.: A Technique for Splanchnic Resection for Hypertension: Preliminary Report, SURGERY **7**: 1-8, 1940.
70. Heuer, G. J., and Glenn, F.: An Evaluation of the Surgical Treatment of Hypertension, New York State J. Med. **41**: 1922-1926, 1941.
71. de Takáts, G., Heyer, H. E., and Keeton, R. W.: The Surgical Approach to Hypertension, J. A. M. A. **118**: 501-507, 1942.
72. Grimson, K. S.: Total Thoracic and Partial to Total Lumbar Sympathectomy and Celiac Ganglionectomy in the Treatment of Hypertension, Ann. Surg. **114**: 753-775, 1941.
73. Grimson, K. S.: The Sympathetic Nervous System in Neurogenic and Renal Hypertension: Experimental Correlation and Clinical Consideration, Arch. Surg. **43**: 284-305, 1941.
74. Grimson, K. S., Wilson, H., and Phemister, D. B.: The Early and Remote Effects of Total and Partial Paravertebral Sympathectomy on Blood Pressure: An Experimental Study, Ann. Surg. **106**: 801-825, 1937.
75. Freeman, N. E., and Jeffers, W. A.: Effect of Progressive Sympathectomy on Hypertension Produced by Increased Intracranial Pressure, Am. J. Physiol. **128**: 662-671, 1940.
76. Talbott, J. H., Castleman, B., Smithwick, R. H., Melville, R. S., and Pecora, L. J.: Renal Biopsy Studies Correlated with Renal Clearance Observations in Hypertensive Patients Treated by Radical Sympathectomy, J. Clin. Investigation **22**: 387-394, 1943.
77. Foà, P. P., Woods, W. W., Peet, M. M., and Foà, N. L.: Effective Renal Blood Flow, Glomerular Filtration Rate and Tubular Excretory Mass in Arterial Hypertension, Arch. Int. Med. **69**: 822-835, 1942.
78. Castleman, B., and Smithwick, R. H.: The Relation of Vascular Disease to the Hypertensive State, Based on a Study of Renal Biopsies from One Hundred Hypertensive Patients, J. A. M. A. **121**: 1256-1261, 1943.
79. Alving, A. S., Adams, W., Grimson, K. S., Scott, C., and Sandiford, I.: The Effect of Bilateral Sympathectomy on the Cardiorenal System in Essential Hypertension, Proc. Central Soc. Clin. Research **13**: 39, 1940.
80. Corcoran, A. C., and Page, I. H.: Renal Blood Flow and Sympathectomy in Hypertension, Arch. Surg. **42**: 1072-1082, 1941.
81. Findley, T., Clinton, E., and Edwards, J. C.: The Effect of Sympathectomy on Renal Blood Flow in Essential Hypertension, SURGERY **12**: 64-67, 1942.
82. Knight, G. C.: The Relation of the Extrinsic Nerves to the Functional Activity of the Oesophagus, Brit. J. Surg. **22**: 155-168, 1934; Sympathectomy in the Treatment of Achalasia of the Cardia, Ibid. **22**: 864-876, 1935.
83. Ochsner, A., and DeBakey, M.: Surgical Considerations of Achalasia: Review of the Literature and Report of Three Cases, Arch. Surg. **41**: 1146-1183, 1940.
84. Mitchell, G. A. G.: The Nerve Supply of the Gastro-Oesophageal Junction, Brit. J. Surg. **26**: 333-345, 1938.

85. Mitchell, G. A. G.: A Macroscopic Study of the Nerve Supply of the Stomach, J. Anat. **75**: 50-63, 1940.
86. Law, J. L.: The Treatment of Megacolon with Parasympathetic Drugs, J. A. M. A. **114**: 2537-2540, 1940.
87. Barenberg, L. H., Greene, D., and Greenspan, L.: Congenital Megacolon (Hirschsprung's Disease), Report of a Case Treated with Acetylbetamethylcholine Bromide With Apparent Cure, J. Pediat. **18**: 579-586, 1941.
88. Gordon, E. J.: The Treatment of Postoperative Abdominal Distention With Prostigmin, SURGERY **7**: 686-695, 1940.
89. Miller, D. S., and de Takáts, G.: Posttraumatic Dystrophy of the Extremities: Sudeck's Atrophy, Surg., Gynec. & Obst. **75**: 558-582, 1942.
90. Atlas, L. N.: Traumatic Vasospastic Dystrophy of the Extremities, Arch. Surg. **42**: 1042-1047, 1941.
91. Hyndman, O. R., and Wolkin, J.: The Sympathetic Nervous System: Influence on Sensibility to Heat and Cold and to Certain Types of Pain, Arch. Neurol. & Psychiat. **46**: 1006-1016, 1941.
92. Lewis, T.: Pain, New York, 1942, The Macmillan Co., 192 pp.
93. Mahorner, H.: Sympathetic Nerve Blocks in Rehabilitation of the Injured Extremity. Report of Cases; and a Discussion of Causalgia, New Orleans M. & S. J. **94**: 426-432, 1942.
94. Homans, J.: Minor Causalgia: A Hyperesthetic Neurovascular Syndrome, New England J. Med. **222**: 870-874, 1940; Minor Causalgia Following Injuries and Wounds, Ann. Surg. **113**: 932-941, 1941.
95. Haven, H., and King, R. L.: Section of the Posterior Roots for the Relief of Pain in Angina Pectoris: Observations in Five Cases, Surg., Gynec. & Obst. **75**: 208-219, 1942.
96. Ray, B. S.: The Management of Intractable Pain by Posterior Rhizotomy, Research Publ., A. Nerv. & Ment. Dis. **23**: 391-407, 1943.
97. White, J. C.: Technique of Paravertebral Alcohol Injection: Methods and Safeguards in Its Use in the Treatment of Angina Pectoris, Surg., Gynec. & Obst. **71**: 334-343, 1940.
98. Perlow, S.: Paravertebral Alcohol Injection for Relief of Cardiac Pain, Illinois M. J. **81**: 35-41, 1942.
99. Levy, R. L., and Moore, R. L.: Paravertebral Sympathetic Block With Alcohol for the Relief of Cardiac Pain: Report of Forty-five Cases, J. A. M. A. **116**: 2563-2568, 1941.
100. McEachern, C. G., Manning, G. W., and Hall, G. E.: Sudden Occlusion of Coronary Arteries Following Removal of Cardiosensory Pathways: An Experimental Study, Arch. Int. Med. **65**: 661-670, 1940.
101. Yodice, A.: Sympathectomy and Experimental Occlusion of a Coronary Artery, Am. Heart J. **22**: 545-548, 1941.
102. Olsen, C. W.: Injury to the Spinal Cord and Spinal Nerve Roots in the Course of Paravertebral Injection, Bull. Los Angeles Neurol. Soc. **6**: 131-134, 1941.
103. Hirschboeck, F. J., and Gillespie, M. G.: A Complication of Paravertebral Injection of Alcohol: Report of a Case, Arch. Neurol. & Psychiat. **48**: 320-322, 1942.
104. Langworthy, O. R., Kolb, L. C., and Lewis, L. G.: Physiology of Micturition: Experimental and Clinical Studies With Suggestions as to Diagnosis and Treatment, Baltimore, 1940, Williams & Wilkins Company, 232 pp.
105. Evans, J. P.: The Physiologic Basis of the Neurogenic Bladder, J. A. M. A. **117**: 1927-1930, 1941.
106. McLellan, F. C.: The Neurogenic Bladder, Springfield, Ill., 1939, Charles C Thomas, Publisher, 206 pp.
107. Bauer, G.: Report at Meeting of Northern Surgical Society, Oslo, June 29-July 1, 1939, reviewed by James Hindmarsh, SURGERY **9**: 151, 1941.
108. Edwards, W. B., and Hingson, R. A.: Continuous Caudal Anesthesia in Obstetrics, Am. J. Surg. **57**: 459-464, 1942.
109. Cleland, J. G. P.: Paravertebral Anesthesia in Obstetrics, Surg., Gynec. & Obst. **57**: 51-62, 1933.
110. Curtis, A. H., Anson, B. J., Ashley, F. L., and Jones, T.: The Anatomy of the Pelvic Autonomic Nerves in Relation to Gynecology, Surg., Gynec. & Obst. **75**: 743-750, 1942.

Book Reviews

Medical Progress Annual. Vol. III. By Robert N. Nye, M.D. Pp. 678, with no illustrations. Springfield, Ill., 1942, Charles C Thomas, Publisher. $5.

This monograph consists of a series of papers on subjects of general interest written by a number of well-known New England contributors, largely from Boston, in the field of their special interests. In the main, papers are written on such general topics as bacteriology, nutrition, pathology, pharmacology, and physiology. There are, however, a large number of specific items involving problems of practical clinical therapeutic interest. In a sense, the book professes to collect the important recent developments and outline the trend of thought in special fields. This objective is achieved particularly well in a number of the essays. In essence, the monograph affects to present the subject matter of year books in many special fields in briefer form. A large number of the essayists are well-known men in American medicine, who write knowingly and critically of recent contributions in their special fields. The volume constitutes an important addition to the review literature of developments in medicine.

Textbook of Exodontia. By Leo Winter. Ed. 5. Pp. 576, with 485 illustrations and 7 color plates. St. Louis, 1943, The C. V. Mosby Company. $10.00.

In this book the subjects of exodontia, local and general anesthesia, and oral surgery are covered in a very thorough manner. The text is designed to provide the student and the general practitioner of dentistry with the fundamental facts of exodontia, and as thorough and detailed a description of the techniques as possible.

The author realizes that the present emergency requires that the general practitioner should be thoroughly familiar with anesthesia and, therefore, has completely revised and brought up to date the chapter on local anesthesia.

The psychologic approach to exodontia patients is discussed, as well as the technique for extraoral injections, the techniques for infiltration and intraoral nerve block, accidents and infections following local anesthesia, general anesthesia in oral surgery, general anesthesia for ambulatory dental patients, chemotherapy, surgical preparation of the mouth for dentures, description and removal of impactions, and cysts of the jaw.

This very comprehensive text should be of great help to the general practitioner of dentistry, especially now that most of the specialists in exodontia and oral surgery are in the Service. The book is highly recommended.

Textbook of Gynecology. By Arthur Hale Curtis, M.D., Professor and Chairman, Department of Obstetrics and Gynecology, Northwestern University, Evanston, Ill. Ed. 4. Pp. 723, with 401 illustrations. Philadelphia, 1942, W. B. Saunders Company.

This book is now in its fourth edition and has come to occupy an enviable place as a well-balanced practical text on gynecology. In this edition, the anatomic studies of the perineum, discussed recently by the author in conjunction with Anson

and Ashley, are reproduced in the graphic manner of their artist-author, Tom Jones. These illustrations, together with the anatomic features of the various surgical procedures, constitute a contribution to the volume. In many of these drawings, the blood vessels and tissue are shown in color. The illustrations throughout the volume are of a high order, and bespeak the importance which the author attaches to augmenting the written word by the enlightening influence of suitable pictures. The text contains 56 chapter headings—all within the confines of 723 pages, including therein, 401 illustrations. The volume can be recommended enthusiastically as a useful and practical text in which the greater emphasis is placed on operative gynecology.

The Hemorrhagic Diseases and the Physiology of Hemostasis. By Armand J. Quick, Ph.D., M.D., Associate Professor of Pharmacology, Marquette University School of Medicine, Milwaukee, Wis. Ed. 1. Pp. 340, with 24 illustrations. Springfield, Ill., 1942. Charles C Thomas, Publisher. $5.

This is an up-to-date summary of our knowledge of hemorrhagic diseases, written by an active and successful worker in a difficult field. The monograph contains an interesting historical account of development of knowledge covering the clotting of blood. The items considered important in the mechanism of blood coagulation are discussed in detail. The avitaminosis K deficiency and the related hemorrhagic diathesis, a field to which the author has added important contributions, are discussed at length and particularly well. The inclusion of an appendix on methods makes the monograph an especially well-balanced and practical book. An extensive list of bibliographic references is appended to each chapter. The book can be recommended enthusiastically as a comprehensive and authoritative summary of our knowledge in the field of hemorrhagic diseases.

Roentgenographic Technique: A Manual for Physicians, Students and Technicians. By Darmon Artelle Rhinehart, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas, Little Rock, Ark. Ed. 3, thoroughly revised. Cloth. Pp. 471, with 201 engravings. Philadelphia, 1943, Lea & Febiger.

The third edition of this standard text on roentgenographic technique is welcome. Some increase in the size of the book and some revisions of the text have been made. There are a number of new figures, some of which are very instructive. It is surprising that the author has chosen to omit such newer procedures as roentgen kymography and body section roentgenography, both of which have an important, though select place, in the methodology of x-ray examination. Otherwise the book is complete. It is well written, bountifully illustrated, and offers a valuable manual for the instruction of technicians and physicians who are concerned with the technique of x-ray examination.

Neurosurgery and Thoracic Surgery. Prepared and edited by the Subcommittees on Neurosurgery and Thoracic Surgery of the Committee on Surgery of the Division of Medical Sciences of the National Research Council. Pp. 310, with 183 illustrations. Philadelphia, 1943, W. B. Saunders Company. $2.50.

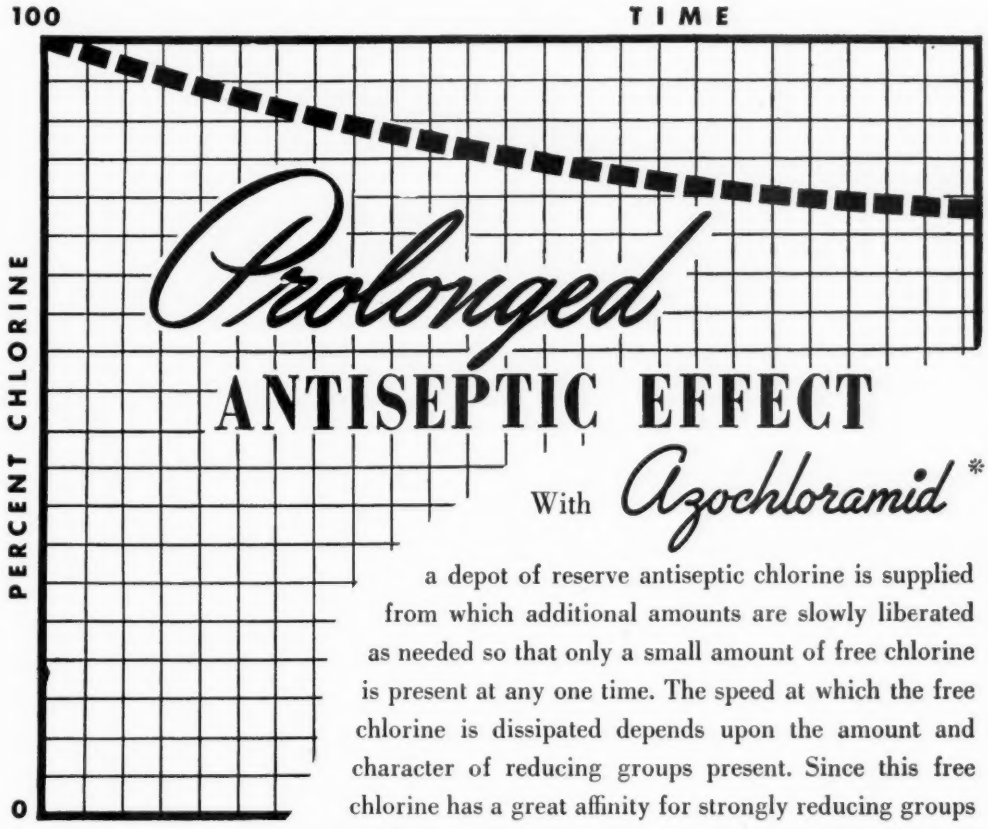
The purpose of this, the sixth of a series of military surgical manuals, is to provide to military medical officers succinct and peremptory information on the management of injuries to the central and peripheral nervous systems as well as on the treatment of thoracic wounds. The volume has been judiciously planned

and comprehensively presented by a group of highly qualified and thoroughly experienced neurosurgical and thoracic specialists. Ample illustrations enhance and elucidate the discussion.

Approximately two-thirds of the book is devoted to neurosurgical subjects. In the first chapter on gunshot and other injuries of the scalp, skull, and brain, prepared by Gilbert Horrax and Claude C. Coleman, specific directions are given for the management of head injuries sustained on the battlefield. Claude C. Coleman and Cobb Pilcher discuss gunshot and other injuries of the spinal cord in the second chapter. The third chapter, by J. Grafton Love, is devoted to the diagnosis and treatment of intervertebral discs in military service, which is equally applicable to civilian practice. A detailed description of the peripheral nerves and a complete discussion of the method of examination of peripheral nerve injuries are presented by Byron Stookey and John Scharff in the fourth chapter. The subject of infections of the nervous system and its coverings arising from injuries sustained in the service is completely covered in the fifth chapter by Charles Bagley, Jr., Francis C. Grant, and Gilbert Horrax.

The last third of this monograph contains a complete though laconic and synoptic discussion of the subject of trauma to the chest prepared by Evarts A. Graham, Isaac A. Bigger, Edward D. Churchill, and Leo Eloesser. First-aid measures, classification, complications, and surgical techniques of thoracic injuries are covered in detail.

Not only has the purpose of the book been commendably achieved, but this manual will find a useful place on the shelf of the civilian surgeon who has been compelled by the exigencies of war to take care of a greater variety of patients.



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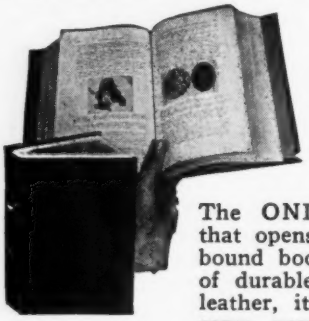

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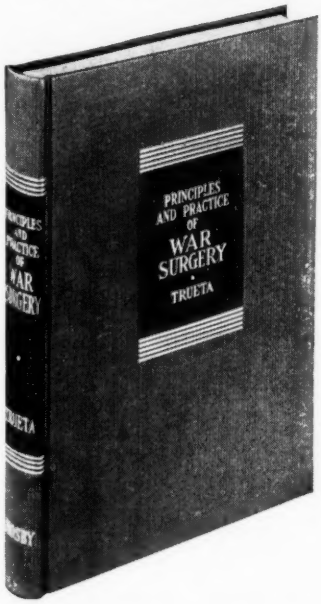

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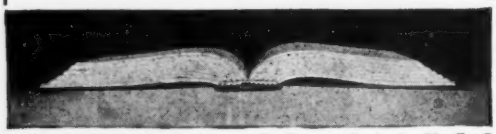

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